Evaluating Express Bus Service

by

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ABSTRACT

Express or limited-stop bus services are a competitive effort by transit agencies to provide higher quality service to customers who make longer trips and place higher premiums on travel time, convenience and comfort. While express routes usually share the same roadway with local, more conventional bus routes, they are intended to differ from local service by making fewer stops, running at higher operating speeds, offering greater comfort to customers, and making trips on a city- or region-wide scale.

It can be difficult to accurately determine the success or failure of express service on a corridor with parallel local service if the evaluation process does not recognize differences in the purpose of each. This lack of clarity hampers the attempts of transit agencies to implement competitive bus services in areas where they may be most effective. A carefully designed evaluation process that recognizes these service role distinctions is necessary to provide an objective basis for decisions to provide higher quality services like express buses or Bus Rapid Transit.

This thesis develops and proposes a normative framework for evaluating express bus services. The framework is applied to the express services of the Chicago Transit Authority (CTA), with particular attention paid to the Authority's experience on Western Avenue. Policy- and operations-level recommendations are provided to the CTA for evaluating express target markets, service design and operational performance.

Thesis Supervisor: Professor Ralph Gakenheimer
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1 Chapter 1: Introduction

1.1 Background

Express, or limited-stop, bus service represents a competitive effort on the part of transit agencies to provide higher quality transit service to customers who place a relatively higher premium on shorter travel times to work or longer distance destinations. While in many cases express bus services share the same right of way as local services, they are intended to differ from local service by doing the following:

- running at higher operating speeds,
- offering greater comfort to customers,
- making fewer stops, and
- making trips on a city- or region-wide scale

The service attributes listed above are also important qualities of Bus Rapid Transit systems. It can be difficult to accurately evaluate the success of express buses or Bus Rapid Transit on a corridor with parallel local service if the evaluation process does not recognize differences in the purpose of each service. This lack of clarity hampers the attempts of transit agencies to implement competitive bus services in areas where they can be most effective. A carefully designed evaluation process that recognizes these service role distinctions is necessary to provide an objective basis for decisions to sustain higher quality bus services.

1.2 Objectives

The main objective of this thesis is to provide transit agencies with a normative framework for evaluating express bus services. Specifically, this framework will be used to provide recommendations to the Chicago Transit Authority in the context of its express service activities on Western Avenue.

1.3 Methodology

1. A literature review will be conducted to develop a definition of express bus service that allows us to identify the characteristics that are most critical for its evaluation.

2. A brief overview of the case of the MBTA's CT1 route will provide insight into the challenges and opportunities facing express services on cross-town routes. Service design parameters, operational performance, and market research will be reviewed using historical documents made available by the MBTA as well as interviews with planning staff.

3. A similar, though considerably more detailed review will be made of the CTA's experience conceiving, planning, implementing and operating the express/limited-stop route X49 on Western Avenue. Data will be used from internal agency reports, published research articles, as well as field-based observations and interviews with planning and operations staff conducted during the summer of 2002.

4. A second literature review will be conducted of publications concerning bus service evaluation techniques for local and express routes. Using the established express service definition and the planning and operation insights gained earlier, appropriate elements and critical inadequacies will be identified.

5. A conceptual framework for express service evaluation will then be developed, based upon earlier experiential insights and the literature review findings. This

approach will provide the basis for series of recommendations to the CTA concerning the evaluation of its express bus routes.

1.4 Thesis Content

Chapter 2 provides an introduction to the concept of express bus services. It places express bus service in a historical context by briefly touching upon the advent of the motorbus in U.S. public transportation. A definition of express buses as a specific transit mode is then developed that will serve to frame its discussion and analysis in this research. Later, a concise overview is provided of the Massachusetts Bay Transit Authority's experience with one of its cross-town limited-stop routes, the CT1. The chapter concludes with an initial identification of a number of challenges and opportunities facing the viability of express bus service, based upon the CT1 experience.

Chapter 3 provides a more in-depth account of the Chicago Transit Authority's efforts to establish cross-town, express/limited-stop service on Western Avenue. A general description is first provided of Western to characterize its role within the city's transportation network. The nature of the CTA's strategic interest in this corridor is identified, as well as the activities that it is currently pursuing there. Future interventions at the route, corridor and system level that stand to make an impact on Western Avenue express service are then outlined. To conclude, a set of key considerations are established for understanding the nature of the CTA's express bus experience on this corridor.

In Chapter 4, an approach to evaluating express bus service is developed. The chapter begins with a review of bus service evaluation literature concerning both local and express route contexts. Techniques, elements and issues that are appropriate for evaluating express services, as well as the inadequacies, are identified. An express service evaluation approach is then developed that takes into account these appropriate elements and inadequacies, as well drawing upon the insights gained from the insights gained from Chapters 2 and 3.

Chapter 5 presents a series of conclusions regarding express service evaluation. Specific conclusions are drawn for evaluating express bus services at the CTA, and these are presented in the form of recommendations to the agency. The chapter concludes with several conclusions about the general discoveries made during this research.

2 Chapter 2: Express Bus Service

The objectives of this chapter are the following:

- Place express bus service in a historical context by touching upon the advent of the motorbus in U.S. public transportation
- Provide a definition of express buses as a transit mode that helps to frame its discussion and analysis in this research
- Examine the experience of the Massachusetts Bay Transit Authority with express service on a cross town route
- Identify opportunities and challenges facing the viability of express bus service

2.1 A Brief U.S. History of Bus Technology and Service

(Cheape 1980; Vuchic 1981; APTA 2002; Wilson 2002)

Motorbuses, or buses powered by the internal combustion engine, first made their U.S. appearance in New York City in 1905 and began the conversion away from the horse-drawn omnibus. In that time, operators who were independent from the streetcar companies that had typically provided public transportation were the first to embrace the motorbus technology. In several of the largest U.S. cities, these operators provided jitney-style service and competed on main traffic routes for customers with the streetcar companies and among themselves. This new source of competition was perceived as a threat by many streetcar companies who reacted by securing the passage of legislation regulating the operation of independent motorbus operations.

By the 1920s, most independent motorbus services had been either reduced or eliminated. However, in their bid to reduce this competition, streetcar companies began to see the merits in using motorbus technology for extending their own services to more lightly traveled routes. This incorporation of the motorbus into well-established public transportation services provided significant impetus for the advancement of motorized bus technology. In 1924, the first gasoline-fueled bus was produced in Oakland, California and its principal features were soon accepted as the standard for buses operated across the country. Additional mechanical innovations increased their durability and comfort and thus increased the value of the technology for operators and passengers alike. The emergence of the diesel engine, with its consumption of lower-cost fuel and higher efficiency, occurred in 1929. Ten years later, the first U.S. buses outfitted with a hydraulic transmission were introduced in New York City.

By 1940, approximately 35,000 buses were providing transit service in the U.S., only slightly less than the total number of streetcars and rail rapid transit cars in use. At that time, bus ridership was approximately half the ridership of the other two modes. By the time the conversion from the streetcar to the bus was complete in 1965, the bus had become the dominant transit mode on U.S. streets.

From the 1970s through the 1980s, little public or private effort at the local or regional level was made to take advantage of European bus technology innovations. During this period, the U.S. federal government provided the only stimulus for this activity through research and development programs. At the same time, the continued accommodation of the private automobile, the suburbanization of homes and employment centers, and a general lack of broad-based political support presented significant challenges to the vitality of the bus as a travel option. In this environment of heightened competition and need for higher-quality transit service, many bus operations were either improved (primarily through priority treatments on mixed traffic roadways) or substituted outright by rail modes. In the case of the latter, buses came to play a significant role as feeder services from suburban communities.

Since the 1990s, several larger transit agencies have been attempting to increase the quality of specific bus services by adopting an integrated approach to improving multiple service attributes known as Bus Rapid Transit, or "BRT". The U.S. experience with BRT, while showing signs in some cases of increased ridership and vehicle productivity, is still in its early stages. As of 2000, the bus continued to be the most extensively used form of public transit in the U.S. (See Figure 2-1).

Figure 2-1: Unlinked Passenger Trips by Mode in U.S. in 2002 (in millions)

Mode	Unlinked Passenger Trips	Percentage of total
Bus	5,678	60.7%
Heavy Rail	2,632	28.1%
Commuter Rail	413	4.4%
Light Rail	320	3.4%
Trolley Bus	122	1.3%
Demand Response	105	1.1%
Other	93	1.0%
TOTAL	9,363	100.0%

Source: APTA (2002). 2002 Public Transportation Fact Book. Washington, DC, APTA.

2.2 Express Bus Service

The motorbus, since its birth in the very beginning of the 20th century, has taken on a variety of forms to suit the needs of transit agencies around the country. Express bus service is one such example. To the author's knowledge, no precise figures are currently available that indicate the percentage of all transit agencies that provide express bus services. It is assumed from anecdotal evidence that service of this kind is provided at most agencies serving moderately to heavily populated cities.

2.2.1 Defining Express Bus Service

Vuchic has established a widely-recognized means of categorizing urban public transportation modes (Vuchic 1981), which is summarized in Figure 2-1.

Figure 2-2: Urban Public Transportation Mode Classification Framework

Right of way (R/W)	A	Full separation of transit vehicle from surrounding environment
	B	Longitudinal separation but at-grade crossing interference
	C	Surface with mixed traffic, with or without preferential treatment
Technology	Support (contact between vehicle and surface)	• Rubber tire on concrete • Steel wheel on steel rail • Others
	Guidance (lateral control)	• Steered by driver • Guided by track • Others
	Propulsion	• Conventional or clean diesel • Compressed natural gas (CNG) • Electric motor • Others
	Control	• Manual/visual • Manual/signal • Automatic
Types of Service	Types of routes and trips served	• Short-haul • City • Regional
	Stopping schedule or type of operation	• Local • Accelerated • Express
	Time of operation	• Regular/all-day • Commuter/peak-hour • Special/irregular

Following the framework summarized in Figure 2-1, Vuchic classifies express bus service as a "transit bus line with long spacings between stations [or stops] that has high operating speed, and serves primarily long trips. It often operates on the same street or R/W (right of way) as a local line with more frequent stopping, …"

It is important to note that express bus service is a term often used interchangeably with "limited stop" or "skip stop" service. To illustrate the similarity of meaning between these various terms, we cite a definition for "limited stop route" provided by Multisystems, Inc. (Multisystems 1983):

> *A "limited stop route" is defined as a route that serves only specially designated stops, skipping intermediate stops. At designated stops, passengers may both board and alight.*

Like Vuchic, the same source defines express or limited stop bus service in the context of a roadway shared with local bus services:

> *A "limited stop route system" is a system of two or more routes operating along the same street alignment that is composed of one or more limited stop routes and (usually) one or more local (all-stop) routes."*

Making reference to a limited stop route *system* composed both of express and local routes implies an important relationship between coexisting express and local bus services. More attention will be paid in Chapter 5 to the identification and nature of this relationship.

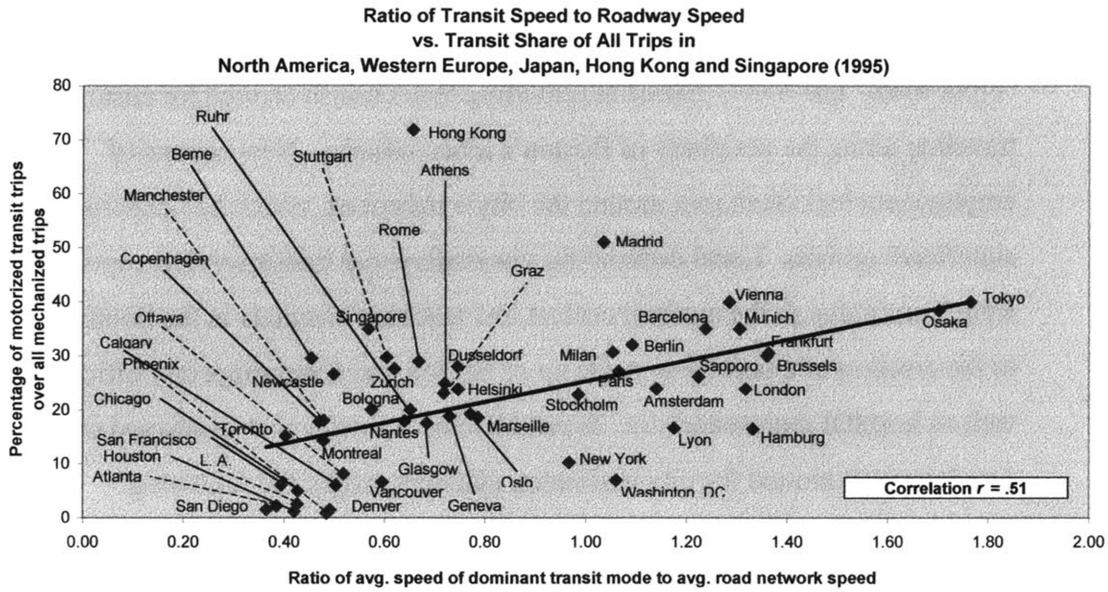
By combining these two definitions of express, or limited stop, bus service and using Vuchic's framework for distinguishing transit modes, we outline the key characteristics of express bus service in Figure 2-2. These characteristics will provide the conceptual basis for the discussion of express bus service for the remainder of this thesis.

Figure 2-3: Express/Limited-Stop Bus Service, Key Characteristics

Right of way	Type C: Surface with mixed traffic, with or without preferential treatment
Technology	• Rubber tires on concrete or asphalt • Individually operated vehicles with manual lateral and longitudinal control
Types of routes and trips served	• City-wide • Regional
Stopping schedule or type of operation	• Express/limited-stop • Fewer stops relative to local service • Higher speed relative to local service

Given the key characteristics of express bus service described in Figure 2-3, an important consideration in understanding its viability involves identifying those markets or customer groups whose needs express bus service is best suited to meet. In Figure 2-3, particular attention is paid to the types of routes and trips served by express buses, as well as their stopping schedule or type of operation. Logically speaking, customers that need to make longer trips (i.e., on a citywide or regional scale) and who value reduced travel time more highly are the ones that stand to benefit most from well managed express bus service.

Figure 2-4: Transit/Roadway Speed Ratio – Transit Market Share Correlation



Source: UITP Millennium Database, 1995

Travel time is a key factor in choosing a transportation mode. An important component of travel time is vehicle speed. It is widely held that the vehicle speed of transit modes affects the number of individuals that rely on transit for their travel purposes. The information presented in Figure 2-4 suggests that in developed countries there is some positive association between the following two variables:

- Ratio of the average speed of the dominant transit mode to the average speed of the road network used by private automobiles

- Share of all mechanized trips made using motorized transit modes

This association between speed and market share is particularly important for the viability of express bus service. To demonstrate its value and compete for market share as a distinct transit mode, it must offer travelers fast service relative to both the car and the local bus.

2.2.2 A Limited-Stop Bus Service Experience: The MBTA's Route CT1

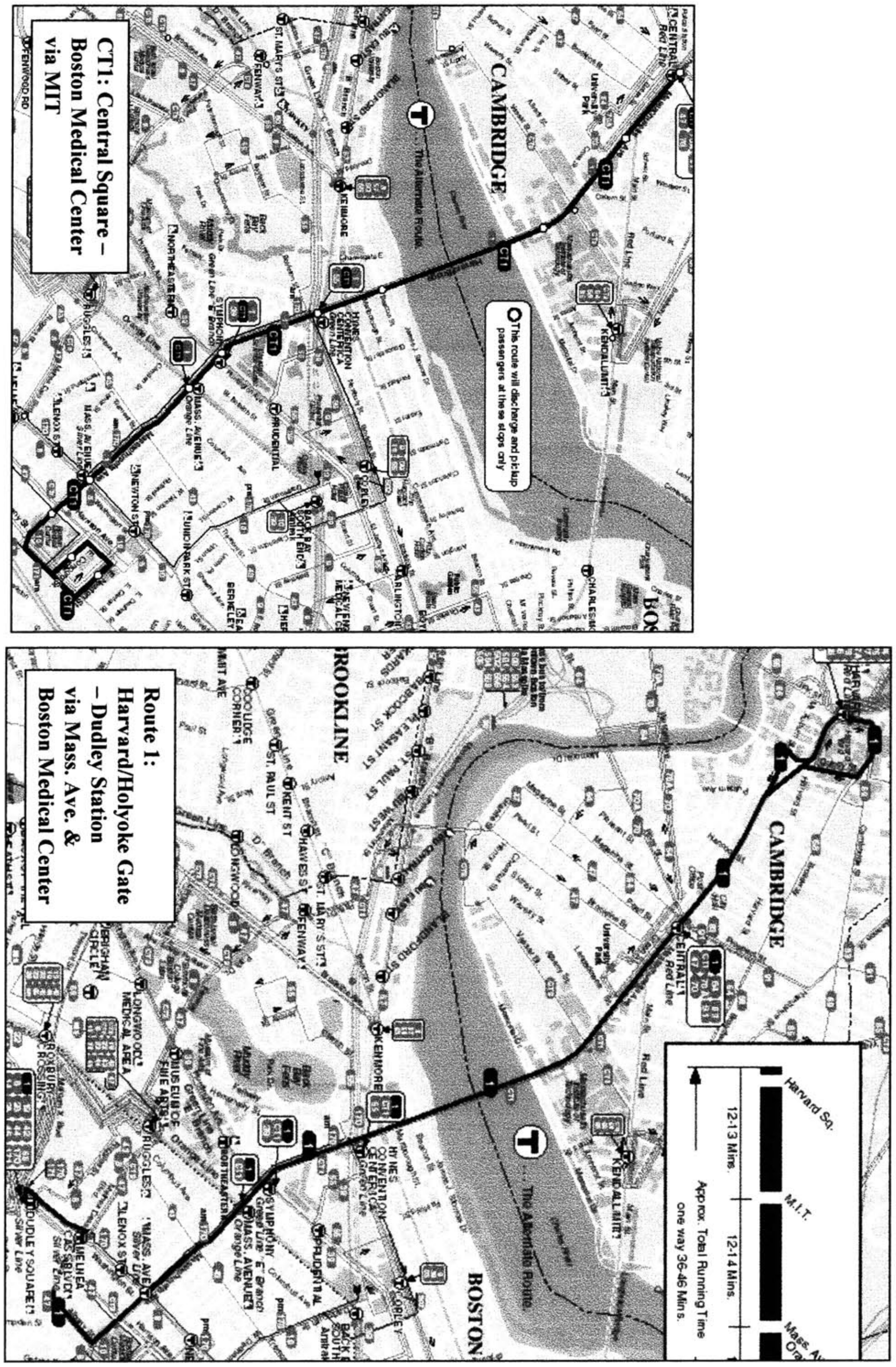
In 1994, the Massachusetts Bay Transit Authority (MBTA) unveiled three new "cross town" bus routes geared at providing faster transit service for customers traveling along the periphery of Boston's inner suburbs. New centers of employment had taken root around the city's perimeter, which had experienced significant growth. Local demand for circumferential transit service, especially from Cambridge to the medical centers and teaching hospitals in the South End, led to the creation of a task force made up of Boston and Cambridge city officials, as well as hospital representatives. In establishing a service that connected major developments around the city perimeter, planners sought the following:

- a more flexible alternative to expensive capital investments in new rail lines,
- a reduction in crowding on the central subway, and
- the attraction of new customers who had not previously used transit for their circumferential journeys (Anonymous 1994).

The task force's work led to the establishment of the following three cross town routes:

- CT1: Central Square, Cambridge – Boston University Medical Center/Boston Medical Center via MIT
- CT2: Sullivan Station – Ruggles Station, via Union Square, Kendall/MIT and Longwood Medical Area
- CT3: Beth Israel Deaconess Medical Center – Andrew Station, via Boston Medical Center

Figure 2-5: MBTA Routes CT1 and Rte. 1



Source: MBTA website (mbta.com)

Of these routes, we will focus on the MBTA's experience with the CT1 for three reasons. First, given that our established definition for express bus service recognizes an important relationship with local bus service on a shared corridor, CT1 provides the best example. Much of the route served by the CT1 on Massachusetts Avenue is also served by its local counterpart, Route 1 (see Figure 2-4). Second, the fact that the CT1 provides service along Boston's perimeter, rather than to the downtown area, will prove useful in the analysis of the case of the Chicago Transit Authority's X49, also a cross town route and the route towards which this research will be applied in Chapter 5. Third, data concerning service design characteristics and performance were most readily available for the CT1 and the local Route 1.

design capacity of 56 passengers stipulated by MBTA service standards. Peak corridor volume in the peak direction is approximately 460 inbound passengers per hour (observed from 7:45 a.m. to 8:45 a.m.). 60% of these passengers are carried by Route 1. The average bus speed observed during this period is approximately 8 miles/hour for Route 1 and 9 miles/hour for the CT1. The peak load point of both routes is located on Massachusetts Avenues.

Harvard Square, Central Square and South End (presumably via the Orange Line transit station) are the most common origins and destinations for riders on both the local and cross town services. The Boston University-Fenway-Longwood area is also a strong trip attractor on both routes.

Route 1 and CT1 are primarily commuter routes, as most riders are either workers or students. Riders on both routes are similar in age (predominantly 18 to 34 years old), gender (relatively evenly split between female and male) and indicated evenly distributed levels of income ranging from under US$ 20,000/year to 60,000/year. Riders on both routes indicated that their top reasons for using transit were its convenience and that it was the only form of transportation available to them. The speed or travel time of Route 1 and the CT1 relative to other transportation options were reasons that riders cited least.

Using data from the a.m. peak period of winter 1999, a basic estimate of travel time savings can be calculated. For example, an inbound trip from Central Square to the Massachusetts Avenue rapid rail transit station on the Orange Line is served by both the local and the cross town routes. The distance of this trip is 2.4 miles. To estimate travel time savings of express or limited-stop routes over parallel local services, the passenger's total travel time is divided into the following elements: the time spent walking to the bus stop (access), the time spent waiting at the stop, the time spent on board the vehicle, and the time spent walking from the stop to one's final destination (distribution). See Figure 2-6 for a schematic diagram illustrating

2.2.2.1 Route Characteristics, Service Design and Operating Performance[1]

Route 1, the local route, provides service from Harvard Square to Dudley Station via Boston Medical Center. The total length of this route is 4.8 miles with an average distance between stops of approximately .13 miles (686 feet). CT1 provides service from Central Square to the South End medical area via MIT, spanning a distance of 3.3 miles with an average stop spacing of .27 miles (1,426 feet). There is an overlap of approximately 70% between these two routes, almost all of which occurs on Massachusetts Avenue. No portion of either route provides transit signal priority or lane exclusivity.

Route 1 provides service over a greater portion of the day and week than does the CT1. Local service begins at approximately 5 a.m. and concludes at 1:30 a.m. (not including the "Night Owl" service, which lasts until 3:30 a.m.). Route 1 also provides service on Saturday and Sunday during a similar time span. Its scheduled headways during the week are 10 to 12 minutes during the a.m. and p.m. peak periods, and 15 to 20 minutes during the off-peak period. In contrast, CT1 only provides service on weekdays from 6 a.m. to 7 p.m.. Scheduled headways on this route are 15 minutes during the a.m. and p.m. peaks, and 30 minutes during the peak period.

Route 1 provides approximately 12,500 trips per day while the CT1 provides approximately 2,200 trips. Both the local and the cross town routes have a vehicle

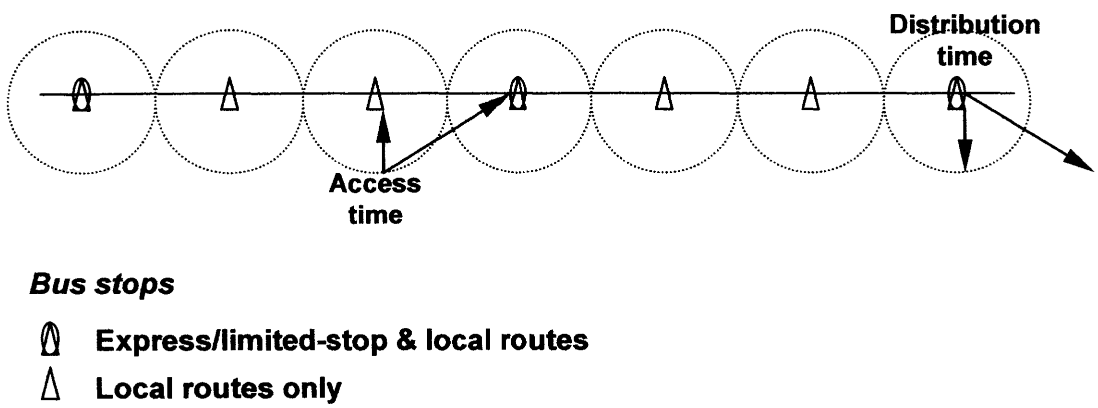
[1] Data for route characteristics, service design and operating performance were taken from MBTA public bus timetables (2002), run time checks (winter 1999), ride checks (fall, winter 1997), bus system passenger surveys (1995) and interviews with planning staff.

this.

Figure 2-6: Total Passenger Travel Time Schematic

Total Passenger Trip Time =

$\textit{Time}_{access} + \textit{Time}_{wait} + \textit{Time}_{ride} + \textit{Time}_{distribution}$



The greater stop spacing of limited-stop or express routes increases operating speed, thus decreasing in-vehicle travel time. This is the obvious advantage of using express over local bus routes. However, where average passenger trips are shorter – such as in the case of Route 1 and CT1 – express in-vehicle time savings can be offset by increased access time (due to the express's more dispersed stops) and by additional time spent waiting if its headway is greater than that of the local route. In other words, a passenger may opt to board the local bus route if they feel that the extra wait time for the express cancels out its in-vehicle time savings. To avoid this, express route headways should be at least equal to the local route in order to demonstrate time savings to passengers, especially those making shorter trips.

Figure 2-7 examines the in-vehicle time savings / headway off-set issue by estimating total passenger travel time based on current versus matched headways.

Figure 2-7: Route 1, CT1 Travel Time and Different vs. Matched Headways

Current headways

Route 1		Pass. Trip Time	
headway	10 min	*Access*	5 min
avg. pass. trip dist.	2.4 miles	*Wait*	5 min
stop spacing	686 feet	*Ride*	22.6 min
time per stop	15 sec	*Distrib*	5 min
moving speed	8 miles/hr	**TOTAL**	**37.6 min**

CT1		Pass. Trip Time	
headway	15 min	*Access*	5 min
avg. pass. trip dist.	2.4 miles	*Wait*	7.5 min
stop spacing	1426 feet	*Ride*	18.2 min
time per stop	15 sec	*Distrib*	5 min
moving speed	9 miles/hr	**TOTAL**	**35.7 min**

Limited-stop total time savings over local
1.9 min
5%

Limited-stop wait time over local
2.5 min

Total time savings--wait time differential
-0.6 min

Matched headway scenario

Route 1		Pass. Trip Time	
headway	10 min	*Access*	5 min
avg. pass. trip dist.	2.4 miles	*Wait*	5 min
stop spacing	686 feet	*Ride*	22.6 min
time per stop	15 sec	*Distrib*	5 min
moving speed	8 miles/hr	**TOTAL**	**37.6 min**

CT1		Pass. Trip Time	
headway	10 min	*Access*	5 min
avg. pass. trip dist.	2.4 miles	*Wait*	5 min
stop spacing	1426 feet	*Ride*	18.2 min
time per stop	15 sec	*Distrib*	5 min
moving speed	9 miles/hr	**TOTAL**	**33.2 min**

Limited-stop total time savings over local
4.4 min
5%

Limited-stop wait time over local
0 min

Total time savings--wait time differential
4.4 min

With current headways for Route 1 and CT1 (10 minutes and 15 minutes, respectively), there appear to be almost no time savings that result from using the CT1. The extra time spent waiting for the CT1 (2.5 minutes) cancels out, from the customer's standpoint, any perceived savings in total travel time. (It should be pointed out that the waiting time estimate in this simple example has not been weighted to reflect its disproportional importance to customers relative to the other components of total trip time. Doing so here would reflect an even greater off-set to perceived travel time savings.) When headways for each route are matched at 10 minutes, however, wait time for both Route 1 and CT1 is the same and travel time savings become more apparent.

The need for matched headways is more acute in cases like these where overall route length and average passenger trips are shorter. As the route length and average passenger trip distance increase, the express total time savings over the local increases more dramatically and therefore is less at risk of being off-set by additional wait time at express stops. However, care should be taken to avoid express-local headway differentials that are *too* great, even at longer distances. This is because customers choosing to ride express versus local generally do so because they are making longer trips. As a result, they appreciate time savings more and have a greater sensitivity to excessive wait time at stops.

In the customer service portion of the MBTA's 1995 passenger survey, riders on both Route 1 and the CT1 indicated that reliability, frequency of service and travel time – in this order – were the most important service quality measures. The CT1 was given slightly higher ratings (on a scale of 1 to 5, 1 being "very poor" and 5 being "very good") relative to Route 1 in all categories. The greatest differences cited between the local and the cross town routes dealt with the availability of seating and cleanliness. A slightly smaller percentage of CT1 riders had issued complaints. Also, responsiveness and satisfactory resolution of customer complaints were twice as high for CT1 riders.

Agency monitoring of service reliability allows for a comparison of schedule adherence between Route 1 and the CT1. The most notable differences concern the percentage of on-time departures and arrivals and are indicated in Figure 2-5.

Figure 2-8: Schedule Adherence for Route 1 and CT1

	On-time Departures		On-time Arrivals	
	Inbound	Outbound	Inbound	Outbound
Route 1	89.7%	88.8%	49.5%	52.7%
CT1	100%	100%	34.2%	25%

Source: MBTA Comprehensive Ridecheck Program, winter/fall 1997

As Figure 2-5 indicates, CT1 appears to have a perfect record for on-time departures, 10% better than its local counterpart. For on-time arrivals, the schedule adherence for both routes is much poorer, and the CT1 lags behind Route 1 by 15 to 20%.

Weekday productivity measures for both the local and the cross town route are given in Figure 2-7.

Figure 2-9: Productivity Measures for Route 1 and CT1 (weekday)

	Subsidy/passenger (US$)	Passengers/ vehicle-hour	Passenger-miles
Route 1	.42	85	41, 625
CT1	1.23	44	4,400

Source: MBTA bus route planning staff, 2002

"Subsidy per passenger" is defined as the amount of additional funding needed per passenger to compensate for shortfalls in revenue. As Figure 2-6 indicates, about three times as much subsidy is required for the CT1 as Route 1. "Passengers per vehicle-hour" refers to the number of passengers carried per hour of revenue service per bus. In this case, Route 1 carries almost twice as many passengers as the CT1. "Passenger-miles" describes the total number of unlinked passenger trips multiplied by the average trip length. While most transit agencies do not track average trip length per passenger(Benn 1995), rough estimates in this case are made based upon the dominant origins and destinations identified earlier. In the case of Route 1, it is assumed that the average trip length is 3.3 miles (Harvard Square – Mass. Ave. Station, Orange Line). In the case of CT1, the assumption is 2 miles (Central Square – Mass. Ave. Station, Orange Line). Given its most common origins and destinations, greater ridership and longer route length, it is no surprise that Route 1 produces considerably more passenger-miles than the CT1.

Interviews with MBTA service planners revealed that passengers waiting for the Route 1 bus have been known to get angry if CT1 vehicles pass them. This is likely the result of two things. First, changes in traffic conditions and peak hour travel present challenges to maintaining evenly spaced headways and evenly distributed passenger loads on Route 1 vehicles. As a result, Route 1 vehicles at their carrying capacity are forced to pass waiting passengers who then become desperate to board any bus – Route 1 or CT1 – traveling in their intended direction. Second, MBTA bus customers on the shared portion of the Route 1/CT1 corridor may not be aware of the service design distinctions between Route 1, a local service, and CT1, a limited-stop or express service. This failure to distinguish one service from another can result from the poor design of devices geared at orienting customers during their transit journey, such as the vehicle livery and design, and stop signage.

At present, the only apparent benefits to using CT1 over Route 1 deal more with comfort and flexibility of fare payment medium than travel time savings. Interviews with MBTA service planners indicate that, in comparison to Route 1 vehicles, CT1 vehicles have a greater number of seats, seats that are padded for extra comfort, are less crowded, and accept subway passes.

2.2.2.2 *Summary of Critical Observations*

- No significant socioeconomic or attitude differences indicating a preference for travel on a particular route were found in the markets served by Route 1 or the CT1. This suggests that passengers do not perceive specific benefits to using one route over the other.

- Route 1 and CT1 buses travel at essentially the same speeds during peak periods. The CT1, with 1/3 the number of stops as Route 1, does not offer substantial travel time savings for passengers. This is hampered in part by its short route length, which reduces the opportunity for substantial time savings over the local service.

- While Route 1 has the lion's share of daily weekday ridership along the corridor (85%), the CT1's share increases to approximately 40% in the peak period. This suggests that the CT1's viability on the corridor is more strongly linked to peak period demand and perhaps the commuter market.

- The CT1's poor productivity relative to the local Route 1, coupled with its lower ridership, weakens the justification of its presence as a coexisting route.

- Anecdotal evidence suggests that passengers cannot or prefer not to distinguish between the CT1 and the local Route 1. This is likely the result of a combination of factors, ranging from poor public understanding of the service provided by each route, to service disruptions that lead to excessive waiting times at stops and passenger desperation to board the next bus, regardless of whether it's Route 1 or CT1. Reducing CT1 headways to more closely match the local service could do much to induce more customers to make regular use of limited-stop service.

- In light of the comments mentioned above, it appears that there is little indication that the CT1 is achieving the faster, cross-town service role for which it was created.

2.3 Opportunities and Challenges for Express/Limited-Stop Bus Services

While the MBTA's experience with the CT1 provides only one example of express bus service performance on a cross-town route, it does allow us to begin identifying a number of opportunities and challenges likely to face similar services in other agencies. These include the following:

- To provide service that can be truly described as *express*, it must have an opportunity to demonstrate sufficient time savings over its *local* bus counterpart. This opportunity becomes more likely as the length increases of both the shared corridor and the average passenger trip.

- Providing productive express and local bus service on the same corridor increases the importance of effective service operations in ensuring reliability. The ability of passengers to distinguish express from local service – and therefore understand the benefits and costs of choosing either – depends on the extent to which they can plainly observe both routes' adherence to schedules on a routine basis.

- By design, the express service is supposed to provide relatively faster travel times to passengers. It follows that such a service would be especially valued among commuters, a group that traditionally places greater importance on time savings as they make their journey to work. The viability of express bus service depends significantly on the devotion of customer groups such as these. The survey findings mentioned earlier indicate that limited-stop customers also value service reliability and frequency.

- In addition to street-level distinctions between express and local service that come from adherence to schedules on a shared corridor, passengers must also be given other clear and consistent cues that allow them to make these distinctions. Such cues can be given via the design of bus liveries, interiors and stops, as well as by driver behavior. Dutiful maintenance of information sources and unwavering marketing activity over the long term also play a crucial role in helping passengers understand the significance of express versus local service.

- Just as the purpose of express bus service is different from that of its local counterpart, there must also be some differences in the standards or guidelines an agency uses to evaluate express service.

3 Chapter 3: Chicago's Western Avenue Corridor and the X49 Express

This thesis seeks to apply its findings to the express bus service provided by the Chicago Transit Authority on Western Avenue. The objectives of this chapter are the following:

- Provide a general description of Western Avenue and characterize its role within the city's transportation network

- Identify the nature of the CTA's strategic interest in Western Avenue, as well the activities that the agency is currently pursuing on the corridor

- Outline future interventions at the route, corridor and system level that stand to make an impact on Western Avenue express bus service

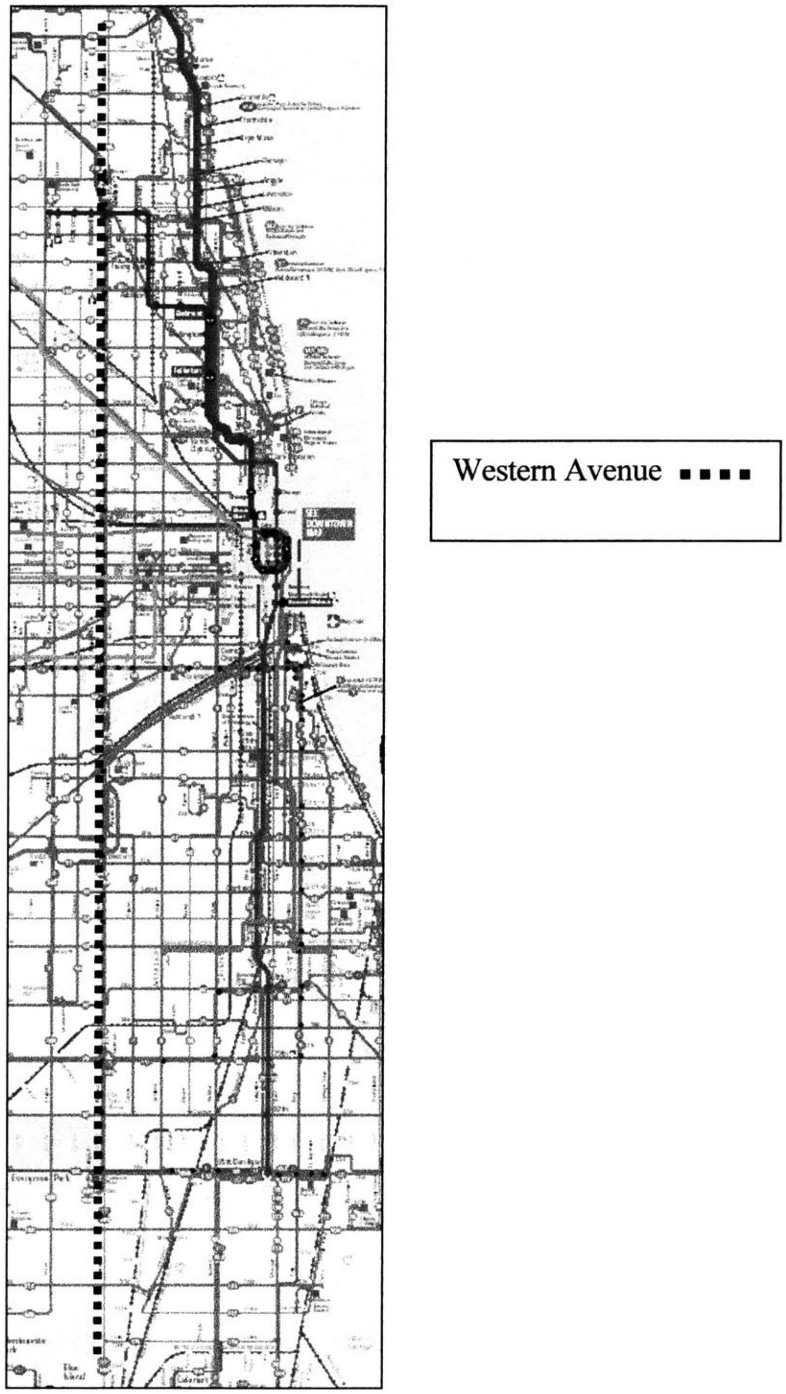
- Establish a set of key considerations for understanding the nature of the CTA's experience with the X49 express bus route

3.1 Description

3.1.1 Location, Land Use, Demographics and Development

Western Avenue is a North-South street approximately three miles west of downtown Chicago (see Figure 3-1). It is considered to be one of the world's longest and straightest avenues – the CTA's combined route length alone on the corridor is approximately 22 miles. Given its significant length, Western Avenue interacts with a variety of neighborhoods and transportation routes. At the midpoint of the 20th century, it was a common destination for a significant portion of Chicago's working class, due to the number of manufacturers and other companies located on the corridor. In recent years, however, many of the labor-intensive industries have disappeared from Western, and the corridor has become less of an employment destination.

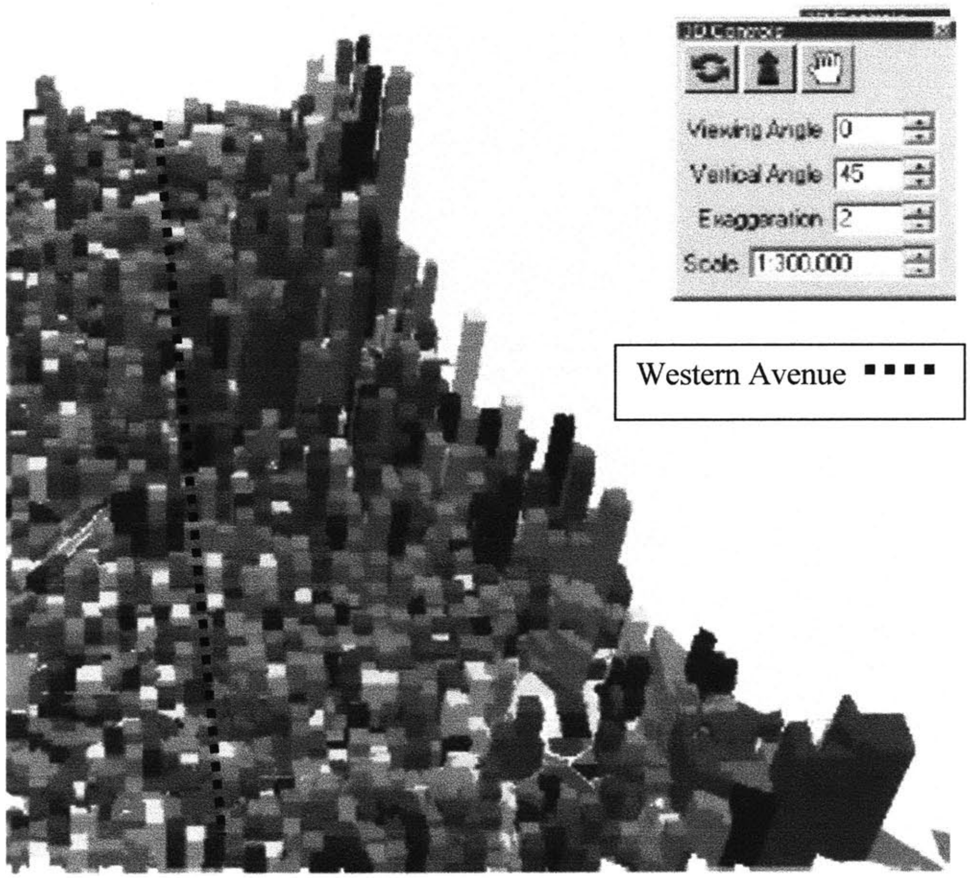
Figure 3-1: Western Avenue, Chicago



Source: CTA website (2002)

Western's northern portion is made up of predominantly middle income communities of Caucasian, eastern European, Asian and Latino backgrounds. The southern portion is composed of middle to lower income African-American and Latino communities. The population density of areas in the vicinity of the corridor is significantly lower relative to the downtown and lakeshore areas (see Figure 3-2).

Figure 3-2: City of Chicago Population Density, 1990



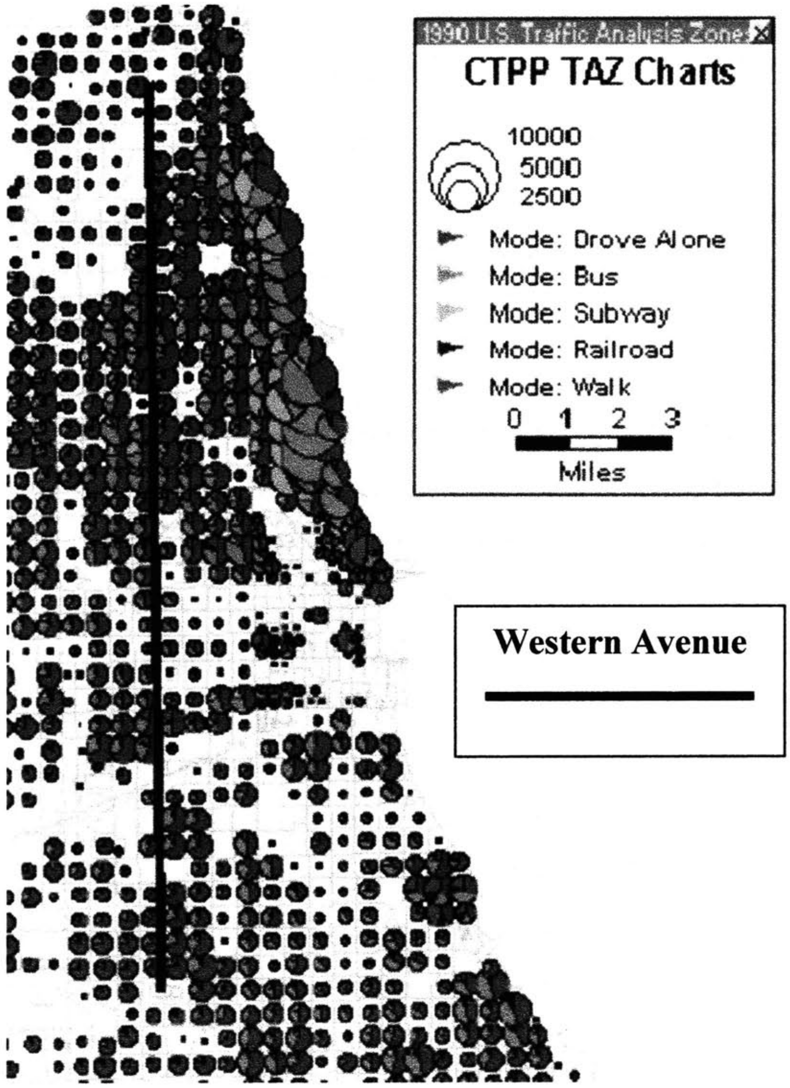
Source: U.S. Bureau of the Census

In addition to the residential areas adjacent to Western Avenue, there are a significant number of small businesses and retail stores. A considerable percentage of these businesses are related to the automobile industry (e.g., car dealerships, car washes, body shops, and auto repair). Real estate development, principally housing, is occurring at an accelerated pace in the areas surrounding the northern and middle sections of the corridor. This is the edge of a westward oriented wave of development originating from the central business district.

3.1.2 Role Within the Chicago Transportation Network

In the transportation context of Chicago, Western Avenue's current role is more of a connecting corridor than a destination. This is a distinction that has important ramifications for the design of transit services that recognize the corridor's role in a larger network. The disappearance cited earlier of larger scale, labor-intensive employment centers along the corridor is one factor that detracts from Western's role as a destination in and of itself. In addition, residential and job growth in Chicago's suburbs has increased considerably over the course of the last 10 to 15 years, increasing the demand for cross-town, rather than CBD oriented, travel. Approximately 85% of trips on all modes in the Chicago area are made outside the central business district (Northwest Research Group 2001). Given its placement outside of the downtown area and the distance it spans in a north-south direction, Western has come to play an important role in facilitating the cross-town movement of private automobiles, transit vehicles and commercial trucks. However, of all modes, driving alone occupies the largest share of the ground travel market in most of the areas adjacent to Western Avenue (see Figure 3-3).

Figure 3-3: Home-based Trips to Work and Mode Share in Chicago, 1990



Source: U.S. Bureau of the Census

In a public transportation context alone, the corridor interacts with number of bus and rail services operated by several agencies. This includes transfer service to 34 bus routes and 5 rail stations operated by the CTA, 3 bus routes operated by Pace (the suburban bus agency) and 2 stations operated by Metra (the suburban rail agency).

Of all the agencies that operate services on Western Avenue, the CTA is by far the most prevalent in terms of ridership, and bus and rail access. The CTA is the second-largest transit agency in the U.S., moving around 1.5 million riders per day (APTA 2002). Figure 3-3 summarizes the agency's bus and rail system figures.

Figure 3-4: Bus and Rail Figures in Chicago

	Bus	*Rail*
Vehicles	1,900	1,100
Routes	~ 134 routes	7 lines
Route-miles	1937 route-miles	222 track-miles
Ridership	~ 1,000,000 pass/day	~ 500,000 pass/day
Stops	12,000	143

Source: (2002). CTA Website, Chicago Transit Authority. Ridership figures are for linked trips, reflecting the fact that more than 50% of all daily CTA customers make at least one transfer (Crockett 2002).

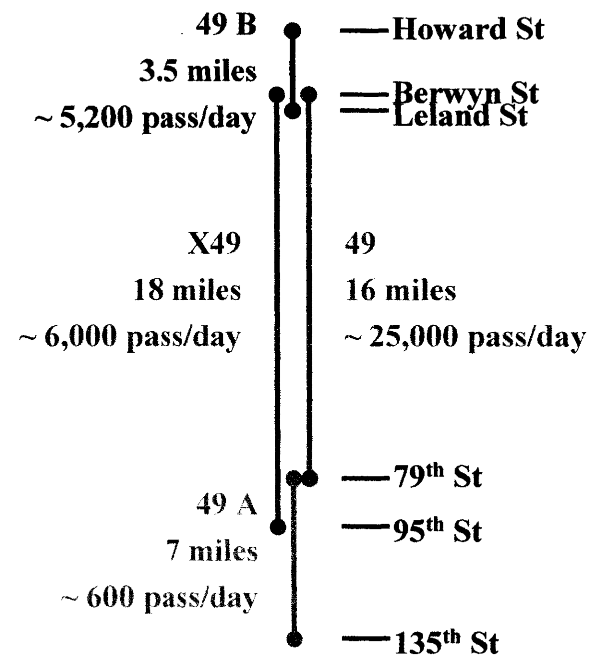
As Figure 3-3 indicates, approximately two-thirds of CTA ridership comes from the bus side operations. Buses generally operate along East-West or North-South routes on a grid-style street network, while rail service is provided via a hub-and-spoke system.

The CTA currently operates the following four bus routes on the Western Avenue corridor:

- Local 49
- Local 49 A
- Local 49 B
- Express X49

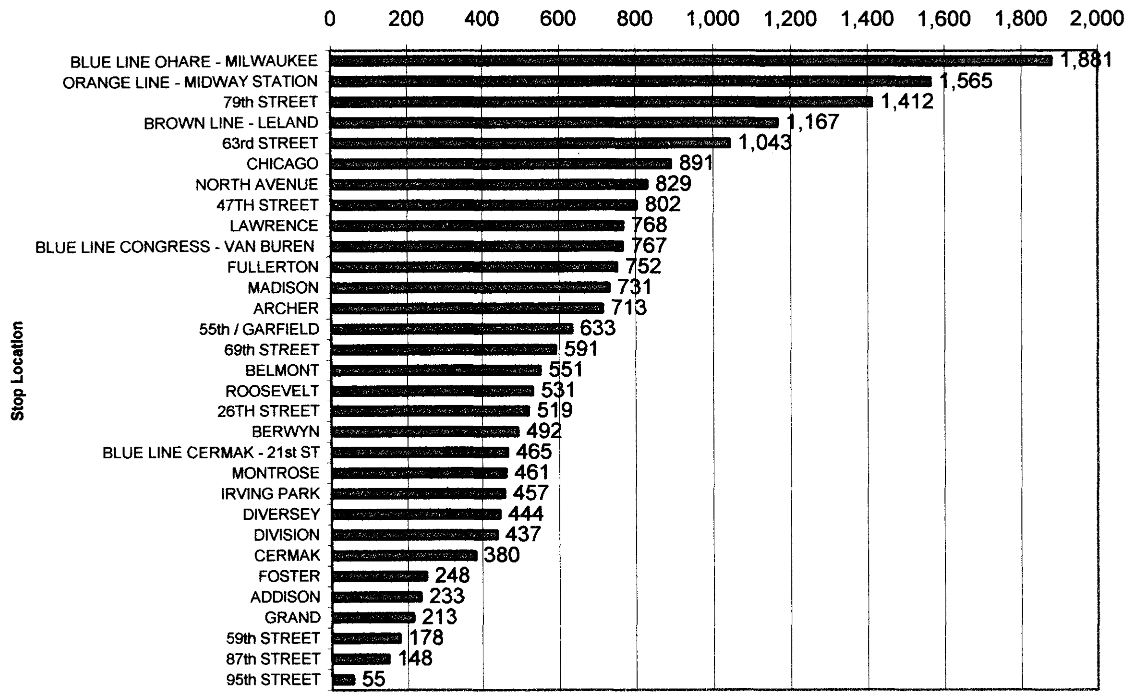
Figure 3-4 provides a schematic overview of each route's individual length and ridership. An obvious item in the overview, to which we will return in following pages, is the disparity between ridership for the X49 (~ 6,000/day) and the local 49 (~ 25,000/day).

Figure 3-5: Schematic of CTA Bus Routes on Western Ave.



The geographical analysis portion of a 2000 customer satisfaction survey of CTA routes 49 and X49 provides additional indication of the corridor's role as facilitating connection rather than serving final destinations (CTA 2000). The origin-destination section of the survey shows that many riders make transfers to or from other routes. A large number of trips made along Western Avenue continue to the downtown area, presumably via transfers to CTA bus or rail routes. Figure 3-5 shows where daily transfers along the corridor are concentrated most heavily. Three out of four of the highest transfer points are located at the following rail stations: Blue Line O'Hare-Milwaukee, Orange Line-Midway and Brown Line-Leland. All of these stations provide direct access to and from the downtown Chicago area.

Figure 3-6: Number of Daily Transfers to/from Routes 49 and X49 to/from CTA and Pace Services



Source: CTA Data Services, 2002

3.2 CTA Interest and Activities 1998-present

3.2.1 The Cross-town Bus Ridership Challenge

As residential and employment growth continued in Chicago's suburbs during the 1980's and 1990's, demand for cross-town travel increased. Given the limitations to providing cross-town rail transit service inherent in traditional hub-and-spoke system configurations like Chicago's, the bus was the only mode at the CTA's disposal to maintaining a presence in the new cross-town travel market. However, while rail ridership showed stability and even slight growth during the 1990's as a result of service quality improvements and infrastructure refreshments, bus ridership in general continued to decline. Most of the CTA's ongoing market share erosion in this area has occurred in cross-town bus trips (see Figure 3-6).

Figure 3-7: Metro Chicago Mode Choice by Trip Orientation, 1990-2000

	Non-Central Business District Trips (85% of all travel)			
	Auto Total	*CTA Bus*	*CTA Rail*	*CTA Total*
1990	76%	20%	4%	24%
1993	80%	16%	4%	20%
2000	87%	8%	5%	13%

Base: Total 2000 Trips (n_w = 5, 769)

* For 2000, CTA rail only 2%; CTA rail/bus is 3%

Source: Northwest Research Group, Inc. (2001). Traveler Behavior and Attitudes Survey: CTA Riders and Nonriders. Chicago, Chicago Transit Authority.

This loss in market share has been taken up by the steady increase in single-occupant auto trips over the past decade. Competition with the auto in the non-CBD travel market is clearly significant, reflecting the high auto ownership of households in the CTA's service area as well as the availability of free parking in non-CBD portions of the service area (Northwest Research Group 2001).

3.2.2 The X49 Initiative

To combat the losses in non-CBD travel market share, the CTA began a series of initiatives focusing on improving service quality and increasing ridership on cross-town bus routes. Many of these efforts were concentrated on Western Avenue for several reasons. First, Western was the most prominent of the CTA's cross-town routes. Its local route, the 49, was one of the best performing bus routes in the CTA system, carrying more than 25,000 riders on weekday basis. Second, bus ridership levels on Western were expected to increase in the future due to the densification trend of the near west Chicago area. Third, the corridor was selected to provide a link to other bus and rail routes, thus augmenting accessibility within the transit network.

In 1998, the CTA launched a new service, the X49 Express. The route was geared toward offering a higher speed alternative with less frequent stops to customers making longer, cross-town trips. The X49 eliminated three-fourths of the local bus stops and increased travel speeds by 24% (Conlon 2000). This route's creation has been deemed by the CTA as the beginning of a series of incremental investments on Western that will eventually lead to a fully developed Bus Rapid Transit (BRT) route. The X49 initiative is considered by the Federal Transit Authority to be the BRT pilot project for Chicago (FTA 1998).

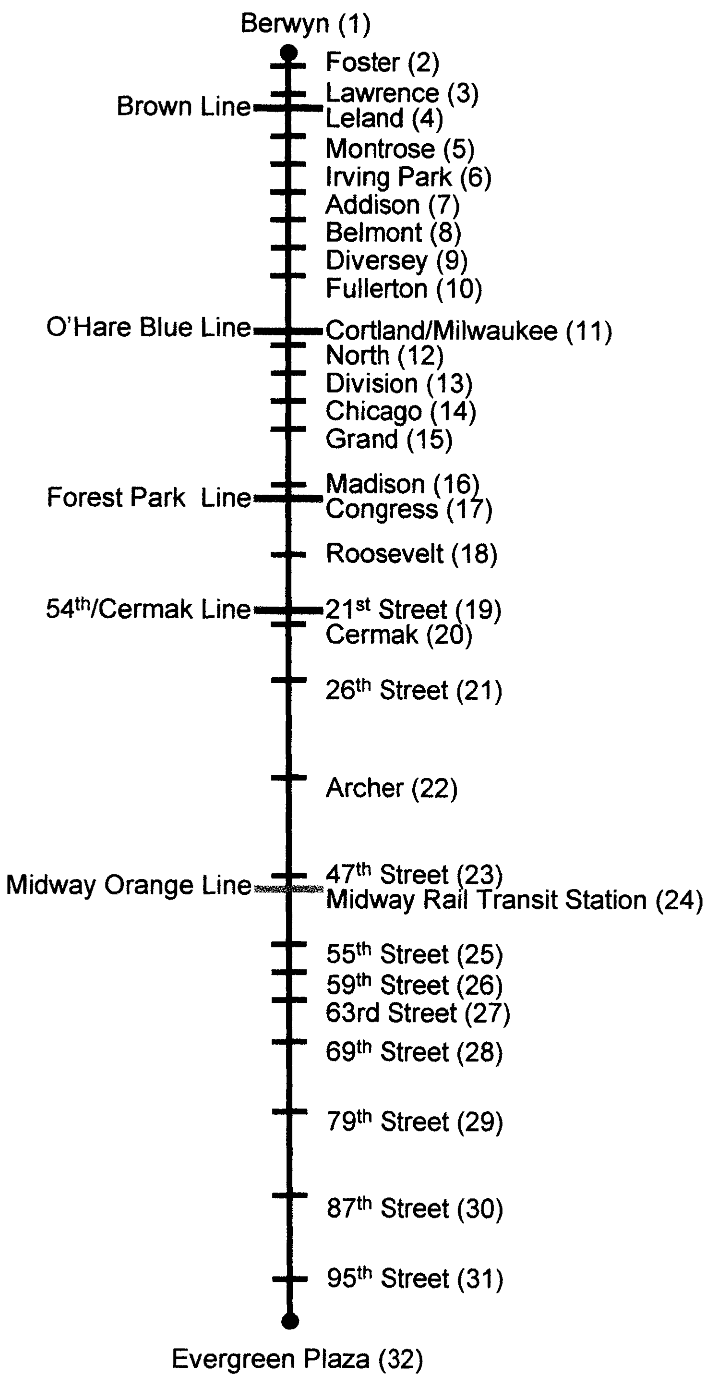
Following is brief characterization of the X49 and a review of its performance.[2] See Figure 3-7 for a schematic overview of the route that includes stop locations and connecting CTA rail stations.

3.2.2.1 Right of way

The X49 runs in mixed traffic, as does the local 49. All portions of the route have at least three lanes in each direction – normally two that are moving lanes and one for parking. No bus guidance system exists in any segment.

[2] Most of the information presented here is based on the following: a review of published literature and internal CTA reports on Western Avenue bus services, interviews with CTA planning and operations staff (including garage and field supervisors), field visits to stops on the X49 route, and on-board travel time data collected by Pilar Rodríguez, a fellow graduate research intern at the CTA during the summer of 2002.

Figure 3-8: Schematic Overview of X49 Route



3.2.2.2 Stops

Southbound stops number 32 and northbound stops 33. Average distance between stops along the entire route is approximately 3,100 feet. However, it is important to point out that there is a significant difference in stop spacing between the northern and southern portions (see Figure 3-7). Average southern stop spacing (4,000 feet) is almost twice that of northern stops (2,200).

In contrast to its express service counterpart, the local 49 has an average stop spacing of 460 feet, which is spread more uniformly across both the northern and southern portions of the corridor.

3.2.2.3 Vehicles

The X49 currently relies on a mixed fleet of buses to provide its service. Some vehicles are Nova (low-floor) buses with 37 seats and a crush load of 90. Others are Flexible (high-floor) buses with a seating capacity of 42 seats and a maximum load capacity of 95.

The CTA currently stipulates a maximum load standard of 60 passengers per bus.

3.2.2.4 Signal System

No active signal priority system for transit buses currently exists on Western Avenue. It has been observed that X49 buses do fall repeatedly into a pattern of successive waves of green traffic signals for extended segments of the route. Drivers and street supervisors indicate that this is more a function of experienced bus driving on Western than of well calibrated signals (Rodríguez 2002).

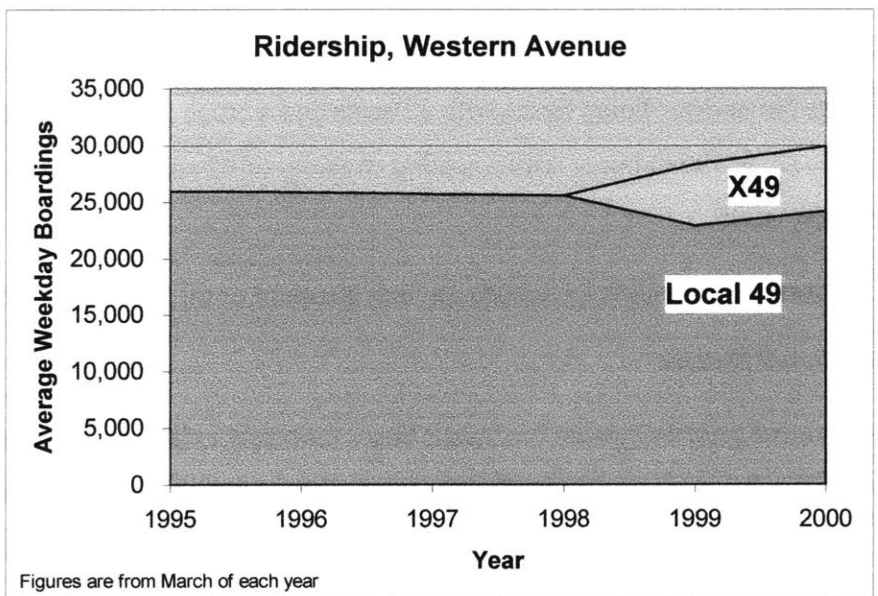
3.2.2.5 Demand

The CTA does not conduct load profiles regularly, but transfer figures for both the express X49 and the local 49 serve as a reasonable proxy for demand at each stop. The total number of transfers to and from both routes – 25,000 transfers/day (see

Figure 3-5) – is approximately 82% of combined ridership (31,000 passenger per day). A very similar pattern of demand exists along stops for both the X49 and the local 49. The stops where demand is consistently high on both routes include Blue Line-O'Hare, Orange Line-Midway, 79th Street, Brown Line, 63rd Street, and Chicago Street.

After the inception of the X49, average weekday bus ridership on Western Avenue as a whole went from 25,500 in March, 1998 to 29,900 in March, 2000 – an increase of 17% (Conlon 2000). This gain appears to have since leveled off at approximately 31,000 riders per day (see Figure 3-9).

Figure 3-9: 49 and X49 Ridership, 1995-2000



Source: CTA (2000). Western Avenue Express. Chicago, Chicago Transit Authority Planning and Development Division.

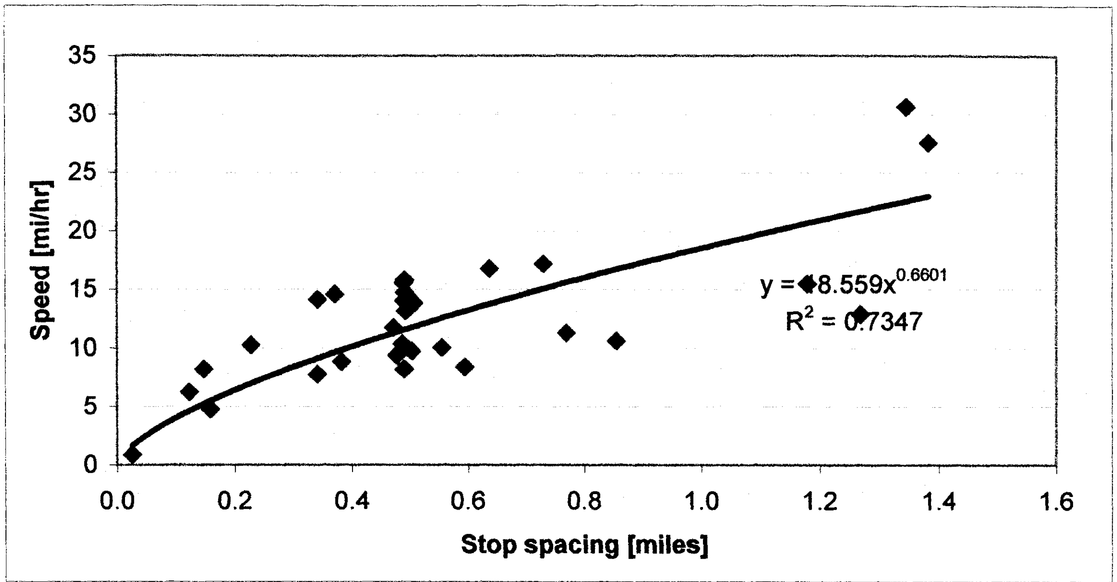
Despite the fact that the pattern of demand as measured by transfer location is similar between both routes, the total daily ridership of the X49 is only one quarter that of the local 49 (approximately 6,000 to 25,000 riders per day, respectively).

The significant increase in ridership witnessed on Western Avenue after the X49's implementation drew much attention within the CTA. Many believed this increase to be customers' response to the uniqueness of the X49's limited stop service design relative to the local 49. Those who have been more skeptical insist that the creation of the X49 simply represented additional, rather than uniquely differentiated, bus service on Western Avenue. This group has attributed the ridership increase to the increased frequency that results from running the X49 and the local 49 on the same corridor.

3.2.2.6 Speed and Running Time

Total running time for the X49 is approximately 2.4 hours round trip (Fall 2001 pick data). 10 to 15% of this time consists of dwell time at stops, 20 to 30% at signals, with the remaining time spent moving. These running time component percentages suggest that efforts to improve the speed of express bus service on Western Avenue can have the greatest impact if focused on signal priority. In addition, there is a marked difference in vehicle speed between the northern and southern segments of the corridor. Due to the fact that stops are spaced more widely in the South, vehicle speeds tend to be greater there relative to the North. Figure 3-10 illustrates the strength of the association between express service stop spacing and speed on Western Avenue.

Figure 3-10: Relationship between Stop Spacing and Speed



Source: Rodríguez, M. d. P. (2002). Moving From Conventional Bus Service Toward Bus Rapid Transit: Establishing Priorities. Civil and Environmental Engineering. Cambridge, Massachusetts Institute of Technology.

The operating speed of X49 buses ranges between 10 and 17 miles per hour. According to CTA sources, the X49 operates at speeds up to 25% faster than its local counterpart.

3.2.2.7 Passenger Travel Time

A rough estimate of the average length of a passenger trip on X49 can be estimated based upon data collected from customer surveys fielded before and after the implementation of the X49 (See Figure 3-11). The data suggest that passengers making trips on the X49 may, on average, make trips that are 1.5 to 3.5 miles longer than those made on the local 49. This may indicate that passengers opt to use the express over the local service for longer trips. More reliable data are needed, however, to make more confident assertions about average trip length on these two routes.

Figure 3-11: Average Passenger Trip Length Estimates for Routes 49 and X49

	Route 49 Before (n = 783)	Route 49 After (n = 643)	Route X49 (n = 453)
Average Passenger Trip Length (mi)	3.2 – 5.2	3.1 – 5.1	4.8 – 6.8

Source: Patzloff, M. V., Jessica; Paquet, John; Bennett, Pat (2002). Memo: Service Analysis on Routes 49 and X49 and Deployment of 45-foot Buses on Route X49. E. V. P. Richard Winston, CTA Transit Operations. Chicago.

The possibility that customers have demonstrated a preference for the X49 when making longer trips conflicts with more anecdotal evidence that suggests riders are indifferent to express or local services. Many passengers that were observed waiting at Western Avenue stops during the summer of 2002 boarded the first bus that arrived, regardless of its distinction as the 49 or X49.

Just as in Chapter 2, Figure 3-12 examines the in-vehicle time savings / headway off-set issue by estimating total passenger travel time based on current versus matched headways. It is assumed, based on the information in Figure 3-11, that average passenger trip distance is 5 miles for both the 49 and X49.

Figure 3-12: 49, X49 Travel Time and Initial vs. Matched Headways

Headways at start of X49

49		Pass. Trip Time	
headway	5 min	*Access*	5 min
avg. pass. trip dist.	5 miles	*Wait*	2.5 min
stop spacing	460 feet	*Ride*	39.3 min
time per stop	15 sec	*Distrib*	5 min
moving speed	12 miles/hr	**TOTAL**	**51.8 min**

X49		Pass. Trip Time	
headway	15 min	*Access*	5 min
avg. pass. trip dist.	5 miles	*Wait*	7.5 min
stop spacing	3100 feet	*Ride*	23.6 min
time per stop	15 sec	*Distrib*	5 min
moving speed	14 miles/hr	**TOTAL**	**41.1 min**

Express total time savings over local
10.8 min
21%

Express wait time over local
5 min

Total time savings--wait time differential
5.8 min

Matched headway scenario

49		Pass. Trip Time	
headway	10 min	*Access*	5 min
avg. pass. trip dist.	5 miles	*Wait*	5 min
stop spacing	460 feet	*Ride*	39.3 min
time per stop	15 sec	*Distrib*	5 min
moving speed	12 miles/hr	**TOTAL**	**54.3 min**

X49		Pass. Trip Time	
headway	10 min	*Access*	5 min
avg. pass. trip dist.	5 miles	*Wait*	5 min
stop spacing	3100 feet	*Ride*	23.6 min
time per stop	15 sec	*Distrib*	5 min
moving speed	14 miles/hr	**TOTAL**	**38.6 min**

Express total time savings over local
15.8 min
29%

Express wait time over local
0 min

Total time savings--wait time differential
15.8 min

Assumptions concerning X49 time per stop and moving speed are made based on travel time observations made in the following thesis: Rodríguez, M. d. P. (2002). Moving From Conventional Bus Service Toward Bus Rapid Transit: Establishing Priorities. Civil and Environmental Engineering. Cambridge, Massachusetts Institute of Technology.

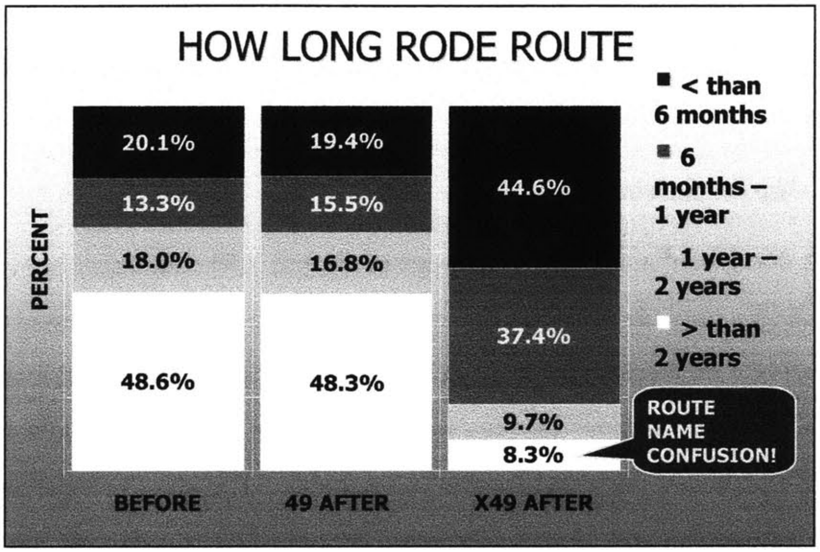
In figure 3-12 we can see that, relative to the MBTA's Route 1 and CT1, the greater average passenger trip distance and express stop spacing of Chicago's Western Avenue make for more significant total time savings over the local route. As a result, the express total time savings (15.8 minutes) are less at risk of being off-set by additional wait time (5 minutes) at express stops. However, care should be taken to avoid express-local headway differentials that are *too* great, even at longer distances like those seen in the case of Western Avenue. This is because customers choosing to ride express versus local make longer average trips, for which time savings become more important. Extended wait times at express stops may weaken customer perception that they indeed save significant time using express service. It is also important to note here that total passenger trip times seen in Figure 3-12 do not necessarily reflect true times for the 49 (CTA running time data for the 49 were not available). Figure 3-12 is rather geared to illustrate the relative wait time offset to total travel time savings at longer distances. It lends weight to the argument that express or limited-stop service provides more travel time savings at longer distances.

3.2.2.8 Market Research

The CTA conducted a number of surveys of 49 and X49 customers both before and after the X49's implementation to determine whether adding the limited stop express service to Western improved CTA customer satisfaction and loyalty ratings. Customer response surveys were also geared at providing information regarding customer demographics and trip purpose. The surveys indicate that customer satisfaction and loyalty improved for both routes following the inception of the X49. There was some indication that customers were more satisfied with the X49 than the 49 with regard to the following service attributes: travel time, bus stop safety, on board safety, reliability and driver courtesy.

The implementation of the X49 did not elicit any noteworthy distinctions from the local service with respect to the demographics of the passengers served. X49 and 49 customers, when compared with CTA bus riders as a whole, tend to be younger in age, report incomes about US$ 10,000 lower, and are more likely to be African-American (Market Research Department 2002). The share of choice riders (i.e., those riders who are not dependent on transit for their mobility or accessibility needs) on both the express and local service increased slightly after the X49's inception. Commuting (to/from school or work) is the purpose of the majority of trips made on either route. A stronger distinction between local and express bus riders concerns the amount of time – measured in months or years – that riders have spent riding the route. X49 riders were more than twice as likely as 49 riders to have used their route for less than six months, or for between six months and one year.

Figure 3-13: Time Spent Riding Routes 49 and X49



Source: CTA Market Research Department. (2002). Technical Report MR00-02: Customer Response to the X49 Western Express Route. Chicago, Chicago Transit Authority.

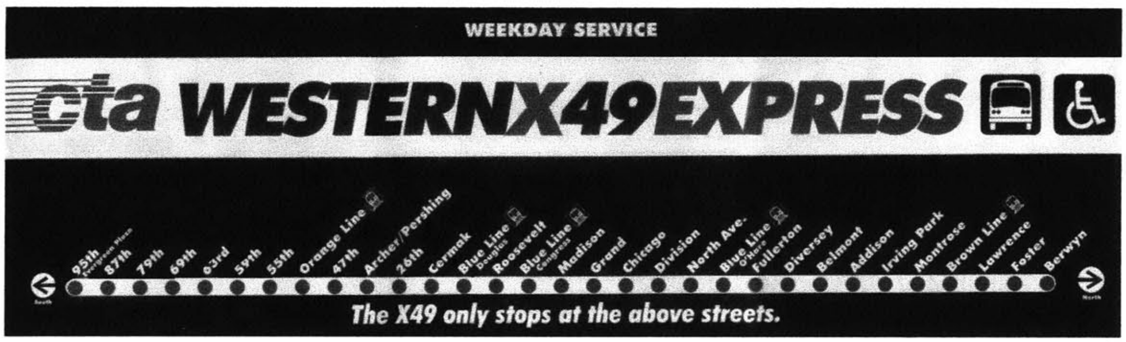
While this may suggest that the limited stop express service attracts more new riders than would otherwise come to the CTA, existing confusion among riders about distinctions between the X49 and 49 makes this assertion less credible.

Overall, the survey's findings do not present compelling evidence that improvements witnessed in customer satisfaction, loyalty and ridership are a result of the uniqueness of the X49's service design. Greater clarity is needed with respect to the relative impact of service level (combined frequency 49 and X49 vehicles) versus service design (i.e., distance between stops for each route) on customer satisfaction and ridership.

3.2.2.9 Customer Information and Visual Cues

When the X49 went into operation, advertisements were placed in selected Chicago-area newspapers and posters were placed in CTA rail stations, rail vehicles and buses. As an effort to promote the X49 as a rapid transit-like service, vehicle car-cards and public flyers were given a design style similar to what was used on the rail system, as shown Figure 3-15.

Figure 3-14: X49 Car-Card

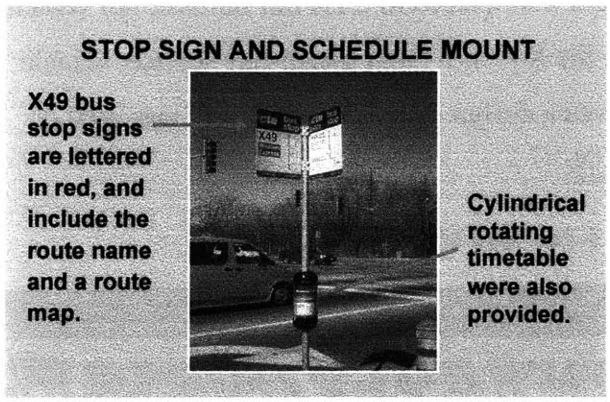


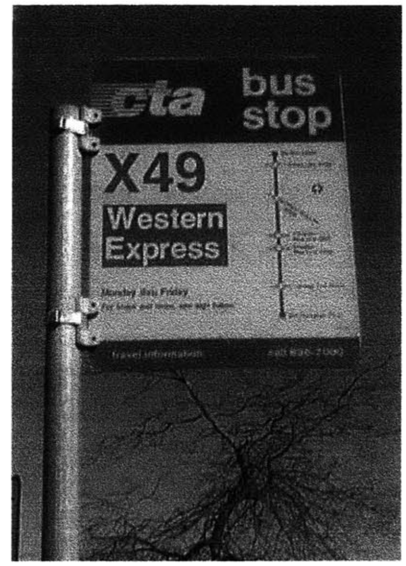
Source: CTA (2000). Western Avenue Express. Chicago, Chicago Transit Authority Planning and Development Division.

In order to help customers distinguish the X49 from the parallel local 49, the CTA tested several visual techniques. The express bus signs were given a pronounced red color scheme. Rapid transit-*like* maps such as the car-card in Figure 3-15 and timetables were made available in rotating, cylindrical signs at every Western Express bus stop (see Figure 13-16). During observations made in the summer of 2002, many of these customer information displays were damaged or missing.

Bus wrapping was not a possibility for the X49 vehicles but the electronic destination signs were reprogrammed to have black lettering on yellow background to distinguish express buses from other buses (which typically have yellow on black)(See Figure 3-17). The intention of this color reversal was to give waiting customers a visual cue as to whether an approaching bus was the one they needed.

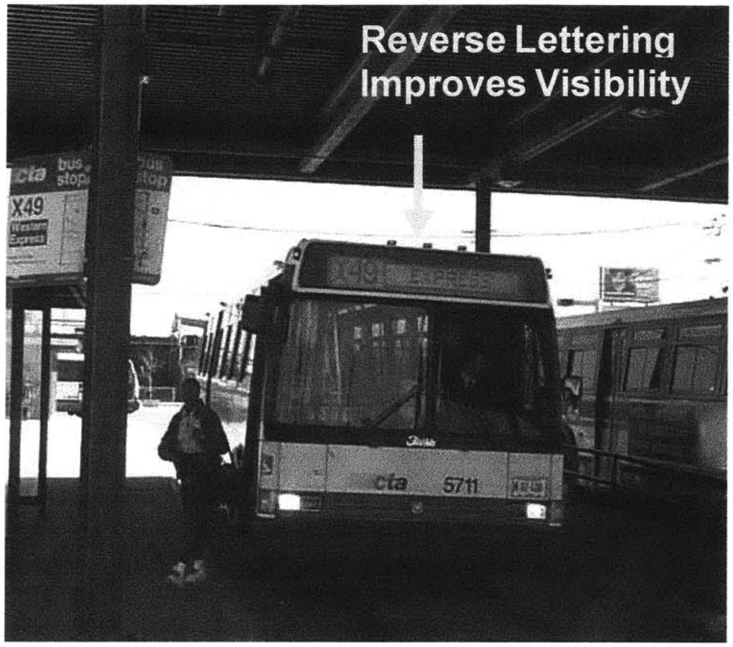
Figure 3-15: X49 Bus Stop Signs and Route Information





Source: CTA (2000). Western Avenue Express. Chicago, Chicago Transit Authority Planning and Development Division.

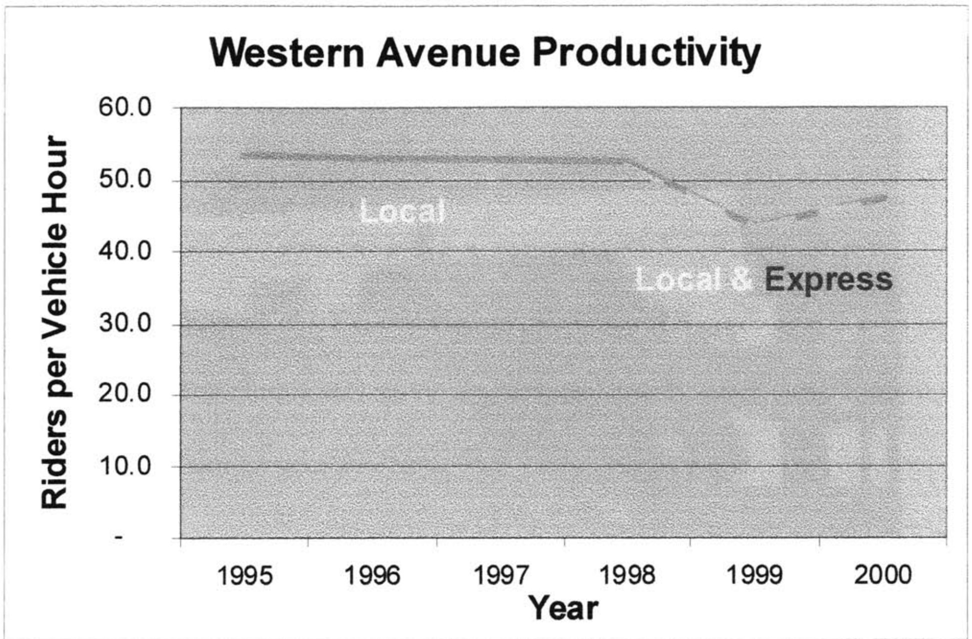
Figure 3-16: X49 Route Information Display



3.2.2.10 Economic Evaluation

The X49 was implemented without any immediate changes to the pre-existing local bus service, and despite the corridor gains in ridership and customer satisfaction, productivity has subsequently dropped within the corridor. The CTA slightly modified service levels on the local 49 in late 1999 to better meet the new level of demand, but additional productivity improvements were still needed. To meet the target, further marketing and promotion were recommended to fill-in the excess capacity. Alternatively, headway adjustments have also been made to address the

Figure 3-17: Western Avenue Productivity, 1995-2000



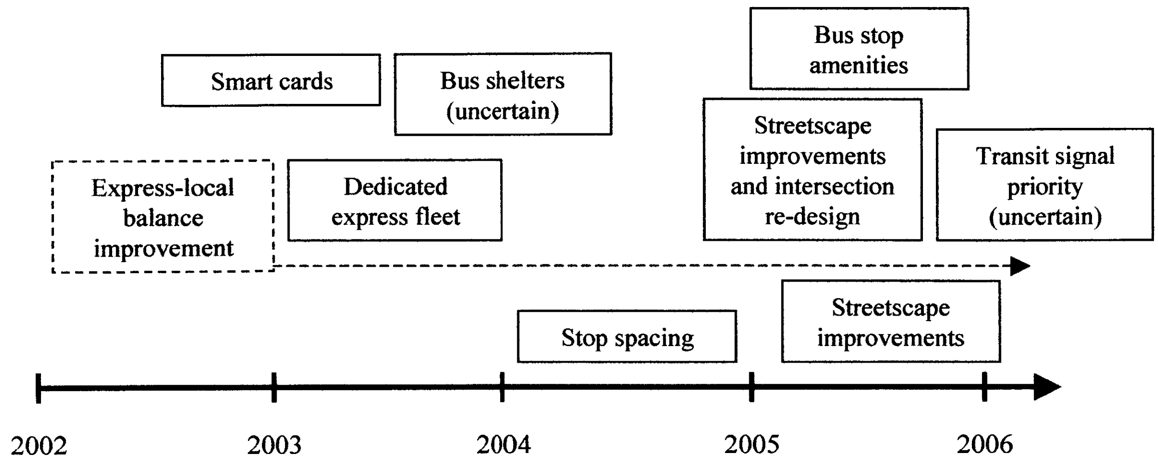
Source: CTA (2000). Western Avenue Express. Chicago, Chicago Transit Authority Planning and Development Division.

productivity issue. As of the summer of 2002, the local 49 was meeting productivity standards while the X49 continued to operate at sub-standard levels.

3.3 Plans and Opportunities for Innovative Applications

There are a number of initiatives, both specific to Western Avenue and more widespread throughout the CTA's transit network, that also stand to impact the performance of the X49 in the short and long term. Figure 3-14 provides the anticipated timeline for these projects.

Figure 3-18: Timeline for Future Initiatives Impacting Western Service[3]



3.3.1 Corridor and Route-level Initiatives

3.3.1.1 Balancing local and express services

The CTA analyzes the local and express bus routes on Western Avenue on an ongoing basis in an attempt to strike a better service balance between the 49 and X49. During the summer of 2002, peak hour headways for the 49 increased from 5 to 8 minutes and decreased from 15 to 10 minutes on the X49. The expectation is that increasing the frequency of the X49 will improve customer perceptions of express service on Western and lead to greater ridership. This is an ongoing effort with staff assigned to its management.

[3] Timeline is based on the estimated year of implementation indicated by CTA staff, internal documents or public literature. It does not reflect the expected duration of each project, which is less certain. "Express-local balance improvement" is an ongoing effort and will respond in part to impacts of the other initiatives.

3.3.1.2 Streetscape improvements and intersection re-design

Plans are also underway for general improvement to the pedestrian areas around Western Avenue stops. The goal of this effort is to make bus service more comfortable, convenient and safer, as well as enhance the appearance of neighborhoods along the corridor. Improvements include better lighting, travel information, and "gateway" treatments. The CTA is also currently putting together a Request For Proposals to contract a consultant to design a model for intersection improvement. Such a model will be applied to Western and other express corridors in the transit network.

3.3.2 System-wide Initiatives

3.3.2.1 Bus shelters and stop amenities

The City of Chicago is beginning a street furniture program with a French firm that may include the installation of bus shelters and benches at Western express service stops at no cost to the CTA. CMAQ (air quality) funding, while not being sufficient to cover all desired improvements, will further enhance the shelters or otherwise help improve bus stop identity along the route.

3.3.2.2 Smart cards

Several years ago, the CTA launched a pilot project aimed at reducing dwell time through the introduction of contact-less smart cards as a medium for fare payment. Following a trial deployment of 3,500 cards, the project was deemed a success. The CTA anticipates a larger deployment of smart cards sometime in late 2002 or early 2003. In addition to reducing dwell time, smart cards could provide more sophisticated traveler behavior data to help guide future service design efforts.

3.3.2.3 Dedicated "compo-bus" fleet

The CTA is currently procuring a fleet of 45-foot buses made of composite materials. The expectation is that these buses will make up a dedicated fleet of vehicles for express routes X49, X80 and X55. The procurement of a dedicated fleet is in part directed at providing a visual distinction between local and express service (i.e., through the use of non-standard paint colors, etc.)

3.3.2.4 Stop spacing

At present, standards for bus stop spacing at the CTA stipulate 1/8 miles (660 feet). Many routes do not meet this requirement, having shorter average spacing. The agency has recently finished the assessment phase of a project aimed at bringing average spacing to standard levels on the 40 routes (five in each garage) for which violations are greatest. Western's local 49 is one such route.

3.3.2.5 Transit signal priority

The Regional Transportation Authority (RTA), the City of Chicago and the CTA are currently examining options for a transit signal priority (TSP) system for a number of regional corridors, one of which is Western Avenue. A feasibility study completed in 2001 by the Chicago Department of Transportation produced promising results for TSP on Western. While the ideal TSP system requires Geographic Positioning System (GPS) technology and a schedule adherence system which the CTA doesn't have currently, there are long term plans for a limited, conditional bus priority system on Western Avenue. The RTA is currently making efforts to assemble the key stakeholders whose support is necessary for the project.

3.4 Key Considerations

Based upon survey data, there is an indication that *some* customers use the limited stop express X49 to make longer trips than the local 49. There is also an indication that the X49 attracted *some* customers who had previously not relied on Western Avenue bus service. This lends some level of credibility to the following beliefs:

- that Western Avenue has transit market potential for travel on a scale greater than local trip-making

- that some customers perceive the X49 as providing greater benefits associated with longer trips

- that a service design like the X49's has some level of success in attracting new customers

However, there is still no strong indication of the degree to which post-X49 implementation increases in ridership, customer satisfaction and loyalty on both Western's express and local routes can be specifically attributed to the X49's limited stop service design. Customer surveys, street-side observations and interviews with CTA staff indicate that both customers *and* bus operators do not consistently distinguish the X49 from the local 49. This suggests that the introduction of the X49 is perceived by many as simply an increase in the frequency of local service.

- It is also uncertain that the travel time savings of the X49 over the local 49 are great enough to persuade customers to forego boarding local buses for the express.

- Despite the corridor-level increase in ridership and customer satisfaction, route productivity for the X49 is still currently at sub-standard levels. Attempts by the CTA to improve this by adjusting headways have been unsuccessful.

- While more precise origin-destination and data are needed, bus and rail transfers to/from Western bus routes approach daily ridership figures for the corridor, and thus provide a reasonable proxy for demand. This suggests that, for the majority of bus users on Western, the corridor plays a connective role in facilitating travel to or from the downtown area.

- Little effort was made by the CTA prior to the implementation of the X49 to study the market potential for express bus service. The absence of this *a priori* market research makes drawing clear, post-implementation conclusions about factors affecting the X49's failure or success more difficult.

- Neither was much effort made to sustain efforts to raise public awareness of the X49 after its implementation. This lack of sustained effort on the agency's part is also related to maintaining bus stop information displays for express service, many of which are either damaged or missing altogether.

It is necessary to have a more effective means of identifying the causes of ridership and customer satisfaction changes before:

- the X49 can regarded as a proven model for providing competitive cross-town bus service,

- the CTA can more confidently design and invest in express bus services in other corridors

4 Chapter 4: Developing the Evaluation Approach

Express, or limited-stop, bus service represents a competitive effort on the part of transit agencies to provide higher quality transit service to customers who place a relatively higher premium on shorter travel times to work or longer distance destinations. While in many cases express bus services share the same right of way as local services, they are intended to differ from local service by running at higher operating speeds, offering greater comfort to customers, making fewer stops, and making trips on a city- or region-wide scale.

It can be difficult to accurately evaluate the success of express bus service on a corridor shared with local service if the evaluation process does not recognize differences in the purpose of each service. This lack of clarity hampers the attempts of transit agencies to implement express service in areas where it can be most effective. The objectives of this chapter are the following:

- Review existing literature on bus service evaluation
- Identify evaluation techniques, elements and issues that are appropriate for express services
- Identify inadequacies in the service evaluation literature with respect to express service
- Develop an approach to evaluating express bus service that a) takes into account the appropriate elements identified in the literature review, b) addresses the inadequacies, and c) draws upon the insights gained from Chapters 2 and 3

4.1 Literature Review

The published work reviewed for this research includes the following sources relating to bus service planning processes, standards, route evaluation, and data collection[4]:

(Benn 1995), (Canadian Urban Transit Association 1993), (CTA 2001), (Furth 1981), (Furth 2000), (Furth 1985), (Gray 1992), (Heathington, Brogan et al. 1974), (Multisystems 1983), (NYCTA 1988), (Odoni 1994), (Siegel 1978), (Toronto Transit Commission 1991), (Urbitran Associates 1999), (Vuchic 1981), (Wilson 2002), (NCTRP Report 16 1988), (Synthesis of Transit Practice 34 1999)

4.1.1 Appropriate Considerations

4.1.1.1 General Observations

Much of the existing literature tends to analyze the design and performance of express bus service in the context of a corridor with at least one other route, normally a local one. This perspective makes sense in that *express* service, by its very definition, is geared to provide a *faster* alternative to travel on a local route. The comparative value of the express alternative relative to the routes with which it shares a corridor is an important basis for judging its worth.

At the same time, the approach to evaluating express bus service is not radically different from that used for evaluating other bus modes such as the local. Barring key distinctions in terms of the market segment that express service is supposed to

[4] This list includes only the name of the author or responsible institution, and the year of publication. For more detailed information, please turn to the Bibliography included at the end of the thesis.

attract (commuters, typically a choice market) and expectations for it to operate at higher speeds, many of the same route design and evaluation sensibilities traditionally needed for local routes are also appropriate for express service. The difference between local and express is often more in the level of importance assigned to performance indicators, such as average speed or customer trip length. In the case of the latter example, the expectation is that express service caters to customers that make longer average trips than local route customers.

As express bus service is designed to offer a relatively higher level of service to customers, many agencies such as the New York City Transit Authority also charge a higher fare for this service. If premium fare is a true option, it can give an agency added room to design express service in a way that distinguishes it from other services (e.g., providing padded seats) (NYCTA 1988). In this case, willingness to pay a premium transit fare also becomes an important factor in gauging the viability of express service.

4.1.1.2 Short-Range Planning and Corridor Analysis

Express bus service planning, as in the case of local service planning, occurs at the corridor and route levels, which are generally considered to be the levels on which most transit agencies focus their short-term efforts (e.g., < 1 – 3 years). In this context, the typical bus service planning objectives and concerns are summarized in Figure 4-1.

Figure 4-1: Short-term Planning Objectives and Concerns

Corridor design objectives	• Reduce cost for existing service • Improve level of service without increasing resources
Concerns	• Changes in waiting time, walk distance, need to transfer
Operational objectives	• Increase operational speed of buses • Decrease vehicle-miles • Decrease unnecessary slack time at terminals • Strive for high uniform loadings on all segments

Source: Furth, P. G. (1981). Designing Bus Routes in Urban Corridors. Civil Engineering. Cambridge, Massachusetts Institute of Technology.

The strategies for achieving these objectives and addressing these concerns can take a variety of local or express bus service forms, which are listed in Figure 4-2.

Figure 4-2: Express and Local Bus Service Strategies

Express	• Zonal express • Limited-stop on express segment
Local	• Short-turning • Restricted zonal • Semi-restricted zonal • Limited-stop zonal

Source: Multisystems, I. (1983). Bus Route and Service Design: Applications of Methods and Procedures (Draft Report). Cambridge, MA, U.S. Department of Transportation, Urban Mass Transportation Administration and Transportation Systems Center.

Regardless of the variety of bus service strategies employed on a given corridor, the literature points to a common set of key issues that must be addressed during the design of a planning process. These issues involve asking the following questions:

- What role do budget constraints play – *before* as well as *after* the budget is set – on the planning process?

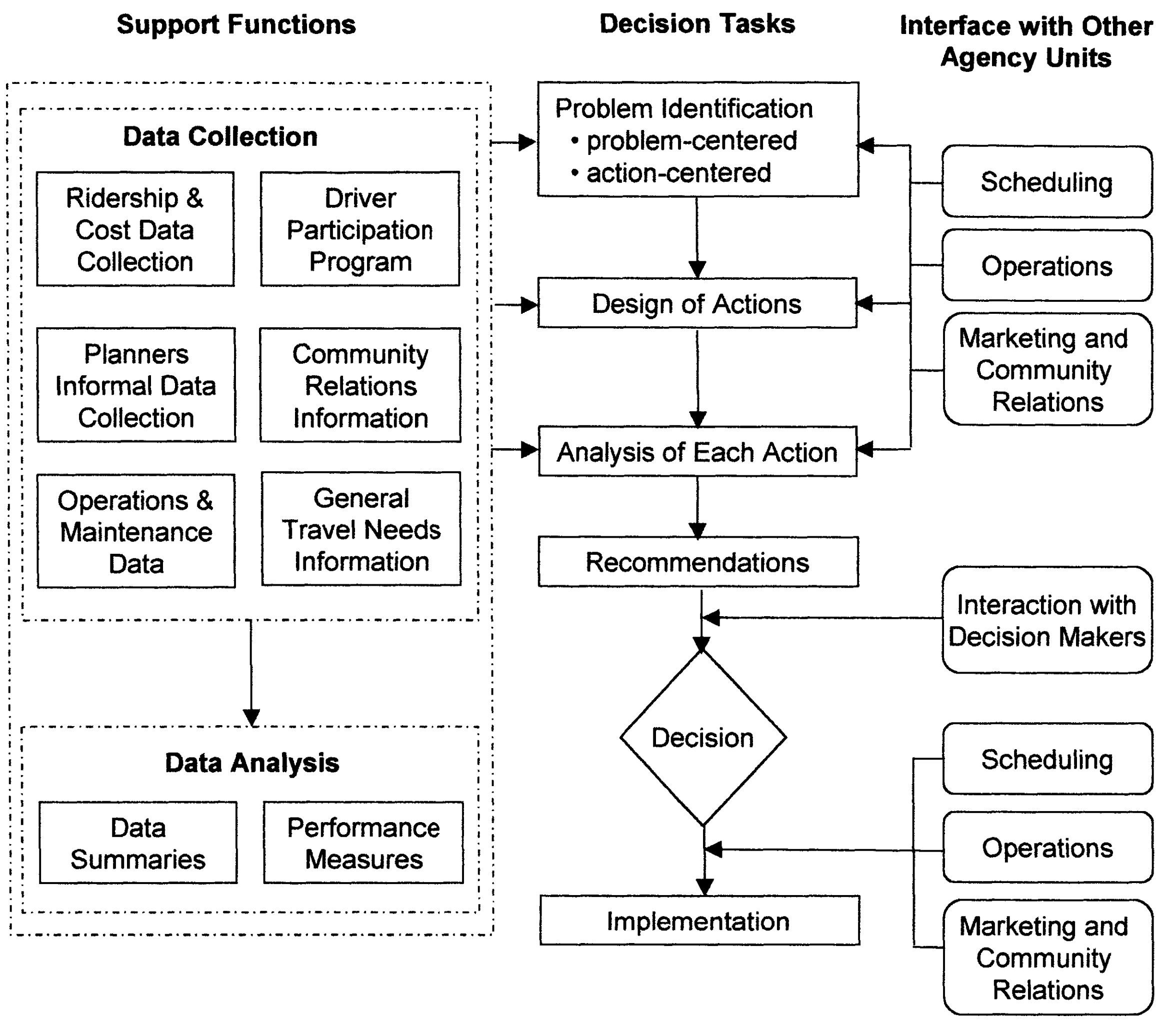
- How much is the planning process driven by reactions to established service standards, versus pro-active investments to obtain the best ridership results?
- To what extent do we consider new service options versus protecting established service?
- How many resources do we allocate to address problematic routes versus routes that may hold more ridership potential?
- To what extent should a route be evaluated according to its individual performance, versus its contribution to the greater transit network?
- What role do service *standards* versus *guidelines* play in evaluating design and performance?
- Are there multiple agency service goals that are in conflict?
- What are the limitations to technical analysis in the planning process?

These key questions address a range of issues affecting a typical short range planning process for bus service at the corridor or route level. Figure 4-3 presents a normative overview of this process.

While the process described above and captured in Figure 4-3 illustrate the necessary breadth of this planning effort, the literature reveals two primary sets of issues concerning the evaluation of express service design and performance. The first set of concrete issues is identified by Furth and Multisystems and concerns the process of sorting through the factors that complicate running parallel local and express bus services (Furth 1981, Multisystems 1983).

These authors assert that the main complicating factor for running local and express on a shared corridor is that some origin-destination pairs may be served by both routes. This obviously gives customers a choice as to which route to use. In this situation, waiting time at the stop for each route is only one of several determinants of route choice. This is due to the fact that reliance on the express route may entail more walking, and so people may choose not to walk to a designated stop, waiting for a local bus instead. However, the greater speed of the express route may induce some customers to pass up a local and wait for an express bus.

Figure 4-3: Example of Short-Range Transit Planning Process



Source: Wilson, N. H. M. (2002). Massachusetts Institute of Technology, Course 1.258: Public Transportation Service and Operations Planning. Cambridge.

Other complications arise when local and express routes overlap, as they often do. It may be that some origin-destination pairs which are not served by the local route cannot be served by the express without an excessive walk distance or transfer to a local route. Furthermore, the time interval between the local and express is likely to vary from stop to stop because each route has a different operating speed.

Faced with the choice of local or express service, many customers, assuming they do not perceive any significant benefit in using one or the other, choose whichever arrives first. The planning challenge in this true-to-life situation is ensure that passenger loads are sufficiently high on both routes. Furth and Multisystems both suggest a carefully thought-out scheduling process to resolve this, involving the use of the same frequency for both routes. They also suggest coordinating route departures if the frequency of one route is a multiple of the other.

Most importantly, the authors put forth a corridor analysis method that consists in the steps shown in Figure 4-4, targeted at a corridor in which both routes operate with the same service frequency.

Figure 4-4: Express-Local Corridor Analysis Method[5]

1. Split the market area of each bus stop in sub-zones.

2. Identify unserved, captive and choice markets.

3. Given the headway and local-express offset, find travel time by each option for the choice market, and split the choice market between the local and express route.

4. Compute volume profiles for each route.

If the peak load of each route is below the design load, then the given headway and offset, together with the given route configuration, constitute a feasible design.

The number of buses needed by a given design is easily computed from the run times and headway. Along with identifying the unserved markets, average wait, walk and in-vehicle time must be computed to make a full evaluation of each service alternative possible.

The method summarized in Figure 4-4 was tested on the Santa Monica Boulevard in Los Angeles, California. It is useful for evaluating express bus service design in that it considers the trade-offs that choice customers – a crucial market for the viability of express service – make between their perceived walking time to the stop

[5] For a more detailed explanation of this method, see pages 65-67 of Multisystems, Inc. (1983). Bus Route and Service Design: Applications of Methods and Procedures (Draft Report). Cambridge, MA, U.S. Department of Transportation, Urban Mass Transportation Administration and Transportation Systems Center.

and their perceived in-vehicle time savings.

4.1.1.3 Express Evaluation Guidelines

The second set of important issues for which some literature is available concerns the use of standards and guidelines for evaluating express bus service design and performance. These aspects are listed in Figure 4-5.

Figure 4-5: Express Service Evaluation Aspects

Service design	• Interval/headway
	• Passenger load
	• Span of service
	• Stop spacing/service coverage
	• Route structure
Operational performance	• Service quality (reliability)
	• Economic performance/productivity

As mentioned earlier, these service evaluation aspects are the primary dimensions along which bus service is traditionally evaluated, regardless of its status as express or local. However, a more detailed examination of some of these aspects reveals key areas where important distinctions are drawn between expectations for local and express service.

Interval/headway

This service design aspect refers to the scheduled interval between successive buses at a given point on a route. It is established to provide a sufficient number of vehicles to accommodate passenger volume at the most crowded locations during a given time period. It is widely considered to be essential that agencies set a standard for a minimum acceptable frequency, thus establishing some degree of reliability according to which customers can make their travel decisions. Together with demand and acceptable peak period loading levels, agency resources are a significant determinant in maintaining minimum acceptable headways.

Passenger load

Passenger load is commonly defined as the number of passengers on buses at the busiest location along a route, and is closely related to the interval. Maximum passenger loading standards are necessary to avoid excessively high loads, which may increase dwell time at stops (thus slowing operating speed on the route) or prevent passengers from boarding the first vehicle that arrives at their stop. In the case of routes with higher levels of service (such as express routes) for which customers may pay a fare premium, some agencies also monitor passenger flow to limit the number of customers forced to stand during peak and off-peak periods.

Span of service

Span of service refers to the hours that bus service is provided and defines the minimum period of time that service will operate at any one point in the system. The intent is to provide customers with a measure of confidence that direct as well as connecting service will be provided during a set time span each day. As a result, a standard must be set for times marking the first and last available runs each day and the operating days of the week. This is an important service aspect for express customers, who tend to rely more on this mode for commuting during the typical a.m. and p.m. peak periods.

Stop spacing/service coverage

Stop spacing or service coverage generally describes the degree of stop distribution along a given route. An important consideration when determining stop spacing is the need to minimize travel time while not creating excessively long access (walk) time to stops. This can be achieved in part by limiting the expected passenger catchment area surrounding the corridor of the express route in question. In the context of a corridor with parallel services, if the non-stop portions of an express route are too short, then critical travel time distinctions from the local route are diminished.

Route structure

As a service design aspect, route structure encompasses the selection of the route's street configuration, its distance from the nearest bus routes or rail lines, and the extent to which the route connects prevalent origins and destinations in a given area. A common planning trade-off in designing express route structure involves selecting streets to achieve higher operating speeds (e.g., wider, arterial streets or limited-access highways) versus the need to minimize passenger access time. Neither should the route be competitive with nearby routes or rail lines unless it can be demonstrated that the route/line does not have the capacity to meet demand. Frequently used route structure standards involve an expected number of passengers per unit of time for a given origin-destination concentration.

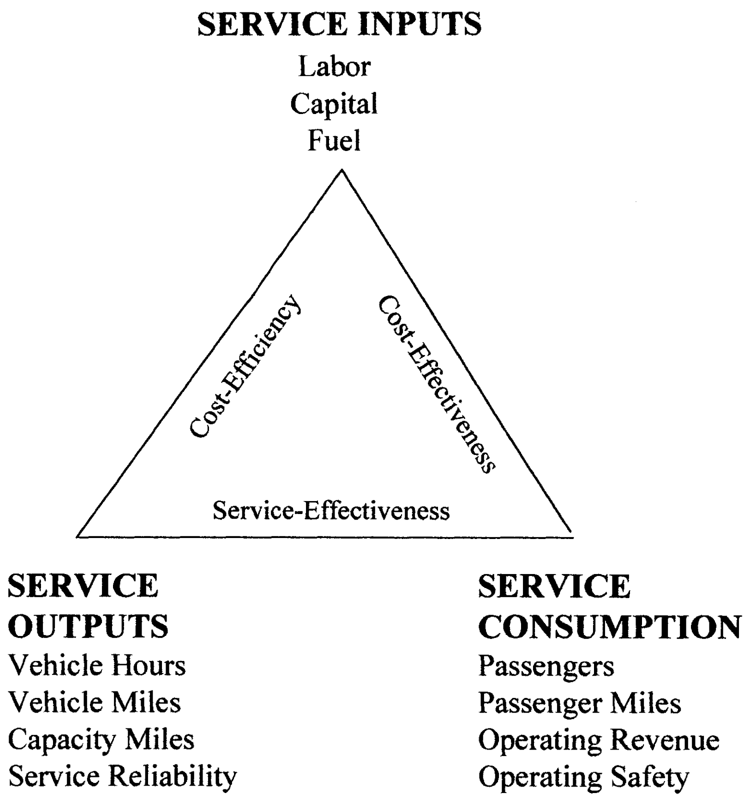
Operational performance: Service quality/reliability

Service quality, or reliability, refers to the degree to which a route adheres to its schedule. Different standards (e.g., the percentage of trips that must depart/arrive within a determined number of minutes of the scheduled departure/arrival) are typically used for low versus high frequency routes. Service reliability becomes more crucial as frequencies decrease on a given route, due to the fact that customers on these routes tend to plan their arrival at bus stops more according to posted timetables than on a random basis (as in the case of higher frequency routes).

Operational performance: Economic/productivity

This aspect of route performance concerns the degree to which a route uses the resources at its disposal to accomplish its service tasks. The dimensions of route economic performance are shown in Figure 4-6.

Figure 4-6: Dimensions of Route Economic Performance

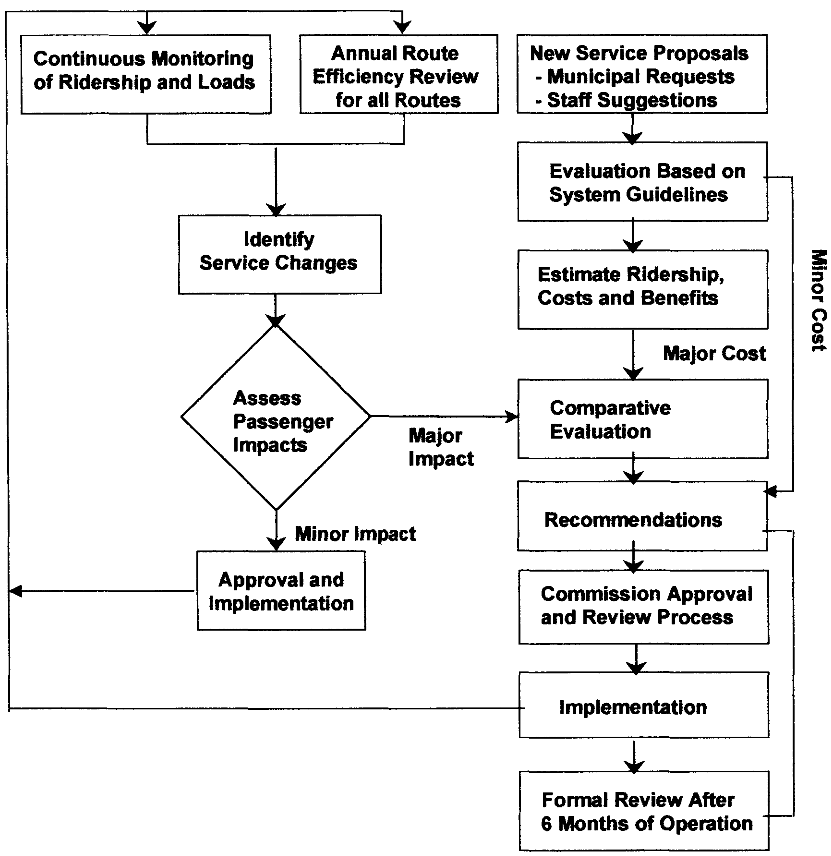


Source: Wilson, N. H. M. (2002). MIT Course 1.258: Public Transportation Service and Operations Planning. Cambridge.

Passengers per vehicle-hour and subsidy per passenger are generally considered to be two of the most critical measures of economic performance (Benn 1995). Using passengers as a proxy for service consumption is good in that it reflects the number of people that benefit from the service and values each person equally. Vehicle-hours provides a good proxy for costs in that it's easy to measure and is related to more than 50% of typical agency operating costs. The subsidy, or net cost, is also a good proxy in that it usually reflects the most direct constraints on service resources. In the context of express bus service, passenger-miles play a more important role than in the case of local route performance measurement. As a benefit proxy, passenger-miles assign greater weights to longer trips, which is of use to agencies that gear express service toward customers making longer average trips. The drawback to using passenger-miles is that they can be harder to measure, depending on the techniques and technologies used within each agency.

Figure 4-7 provides a sample overview of the process that the Toronto Transit Commission (TTC) uses to incorporate the design and performance evaluation aspects discussed in this section.

Figure 4-7: Service Standards Process, Toronto Transit Commission



4.1.1.4 Data Collection and Processing

Data collection and processing form a critical part of transit evaluation processes. However, compared to existing literature on corridor analysis and service planning for express bus services, there is much less information available about data collection efforts in the same context. At the same time, the data collection literature that does exist, while applicable to evaluating a broader range of bus services, presents some relevant considerations for express bus service.

There are a number of general caveats to be aware of when designing any transit data collection program. First, there is significant variation in data collection resources, techniques, and know-how among agencies. Any data collection efforts undertaken by the agency must begin with an honest assessment of its constraints in this area. Second, many agencies do not use statistical approaches that account for data variability or that incorporate a level of required accuracy. Furthermore, many transit planners have little trust in data as a resource for making decisions; rules of thumb and personal experience are often relied on to a greater extent.

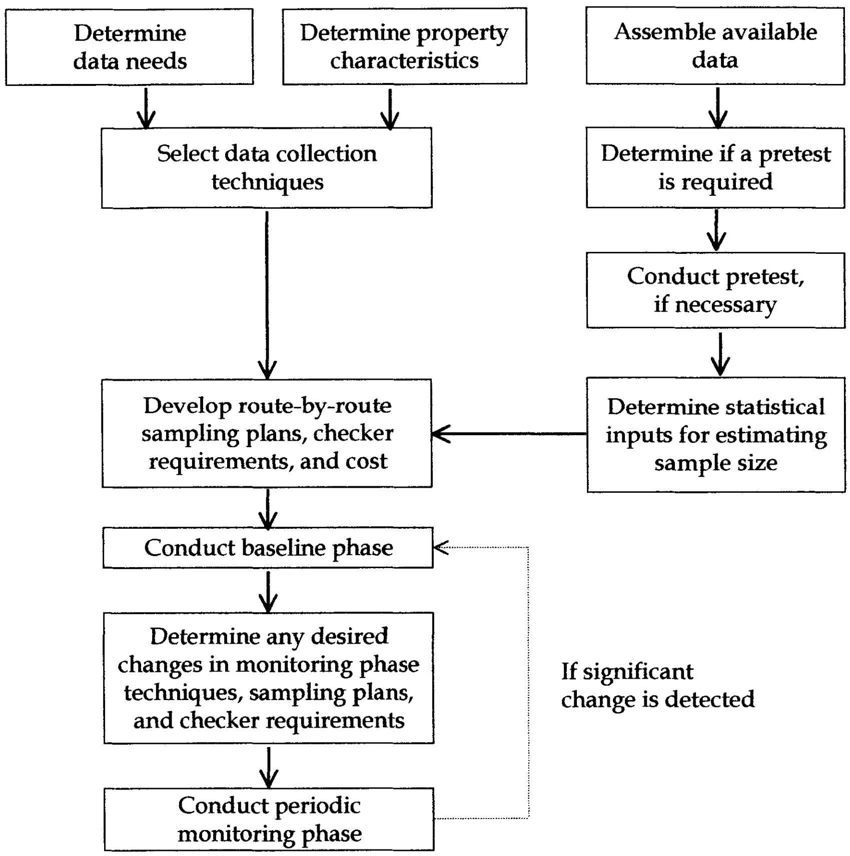
Figure 4-9 summarizes a generally accepted overview of the design and implementation of a data collection program. The primary elements in this program are summarized in Figure 4-8.

Figure 4-8: Data Collection Program Elements

Baseline	• Develop route profiles • Define base conditions • Develop conversion factors
Monitoring	• Detect changes based on selective data collection • Use conversion factors to estimate other data
Follow Up	• Develop new route profiles • Select additional data • Special studies

Source: Furth, P. G. A., J.; Burns, I.; and Wilson, N.H.M. (1985). Transit Data Collection Design Manual - U.S. DOT Report DOT-I-85-38, U.S. Department of Transportation: 1-121.

Figure 4-9: Summary of Data Collection Program Design and Implementation



Source: Wilson, N. H. M. (2002). MIT Course 1.258: Public Transportation Service and Operations Planning. Cambridge.

4.1.2 Inadequacies

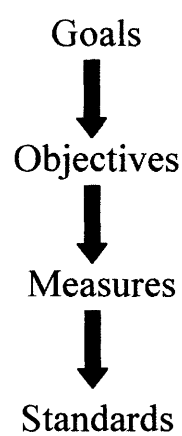
4.1.2.1 Comprehensive Approach for the Express

Many of the sensibilities involved in evaluating local bus service design and performance are useful in approaching the same issues for express services. However, a specific, comprehensive treatment of the issues unique to evaluating express services is lacking in the literature. This would be especially useful in addressing the value of performance indicators, such as average speed or customer trip length, which is different in an express service context.

4.1.2.2 Overarching Goals and Agency Policy

Little mention is made in express bus service literature concerning the role of overarching agency goals in determining the nature of objectives and standards. Establishing standards for express service has little meaning unless such standards allow an agency to track its progress toward achieving broader, explicit goals for transit service. Linkages in this evaluation structure must reflect this connection (see Figure 4-10).

Figure 4-10: Overarching Evaluation Structure



4.1.2.3 Time Savings as an Operational Performance Measure

Absent from bus service evaluation literature are measures that help agencies to comparatively gauge the performance of higher level-of-service modes that place a premium on operating speed. Travel times savings is a critical point of distinction and justification for the existence of express routes that run parallel to local routes.

4.1.2.4 Evaluating Market Characteristics

The viability of higher level-of-service transit investments is linked to the level of demand for such services. The very notion of establishing a bus service with distinctive service design qualities in operating speed or vehicle comfort indicates that there is a customer market that especially values this kind of service. Nevertheless, documented approaches to evaluating the strength or size of these target markets are less sophisticated than approaches for determining service design or operational performance measures. Transit agencies intent on providing express bus service should carefully consider customer characteristics like demonstrated preference for express routes, perceptions of travel time savings over local, and willingness to pay premium fares.

4.1.2.5 Orientation to the Central Business District

In the few cases where express bus service evaluation is dealt with explicitly, it is in the context of providing travel for which the central business district is the significant origin and/or destination. However, the increase in cross-town or peripheral trips in many U.S. cities suggests a need to also examine the design and performance of express services where demand is not oriented toward the CBD.

4.1.2.6 Multiple Express Strategies and Dedicated Markets

The literature review reveals a variety of express and local bus mode options from which an agency can choose when seeking to provide faster service to its customers (see Figure 4-2). It is uncertain whether these somewhat subtle distinctions among multiple service strategies are more a part of transit theory than commonly implemented by agencies. The criteria used for evaluating express bus service by agencies like the CTA, however, do not carefully distinguish the roles of two service options (local and express), let alone *six* different strategies. If agencies entertain a variety of options that is too wide, without first ensuring that clear, distinguishable benefits of each can be demonstrated to customers, they may risk operating routes that are not viable.

4.2 Proposed Express Service Evaluation Approach

4.2.1 Key Assumptions

4.2.1.1 Shared Corridor: Overlapping Express-Local Routes

The express service evaluation approach proposed here does so in the context of a corridor shared with a local bus route. By its nature as a higher-quality transit alternative to local service, its viability depends largely on the extent to which it demonstrates its distinctive benefits to customers relative to local routes. In addition, Chicago's Western Avenue, the corridor of practical interest to this research, has an express and local route between which there is a significant overlap.

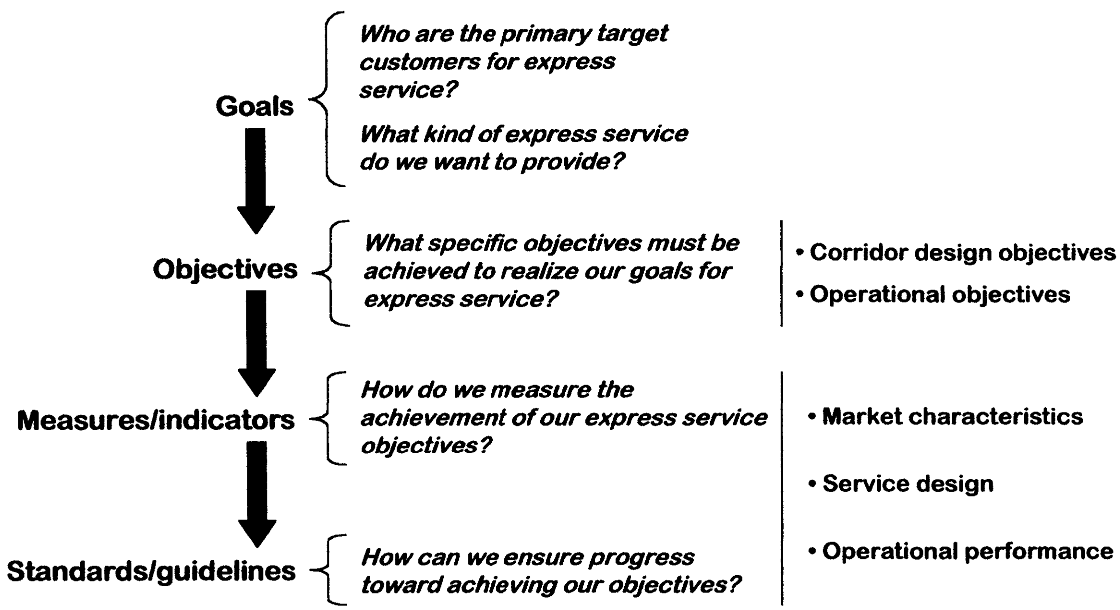
4.2.2 Pre-Planning: Linking Service Goals to Standards and Guidelines

Before an agency can begin the process of evaluating its express services, it must establish a structure of linked goals, objectives, measures and standards or guidelines that reflect the agency's motivations in this area. Figure 4-11 provides an overview of this evaluation structure.

4.2.2.1 Express Service Goals

It is important to begin developing the evaluation structure by identifying the key characteristics of the customer group or market for whom express bus service is best suited. Key considerations involve how customers in this group value travel time, convenience, and comfort. Based upon this profile, what is the service value that the agency seeks to provide to this customer group? This express service value proposition should be widely known throughout the agency. Do the goals established for serving an express customer market conflict with other goals within the agency?

Figure 4-11: Overview, Proposed Express Evaluation Structure



4.2.2.2 Express Service Objectives

To realize the broader express service goals an agency sets for itself, a series of more concrete, shorter-term objectives relating to corridor design and operations must be established. Common corridor design objectives include reducing the cost of existing services, or improving the level of service without increasing resources. Operational objectives in an express service context should place particular emphasis on a relatively higher operating speed for buses. At this stage it is important to have a clear understanding of the budget limitations that will constrain the express service design.

4.2.2.3 Express Service Measures or Indicators

An agency must have a means of tracking the achievement of its express service objectives and developing specific evaluation measures or indicators provide the tools for doing so. Express service evaluation measures should be organized according to the three aspects and respective sub-aspects listed in Figure 4-12.

Figure 4-12: Proposed Express Service Evaluation Aspects

Market characteristics	• Travel behavior • Travel attitudes/preferences • Socio-economic characteristics
Service design	• Interval/headway • Passenger flow • Span of service • Stop spacing • Route structure
Operational performance	• Service quality/reliability • Economic performance/ productivity • Time savings

Many of the evaluation aspects shown in Figure 4-12 are based on service design and operational performance concepts addressed in Section 4.1.1.3. There are, however, several important additions. *Market characteristics* make up an entirely new evaluation aspect and encompass several key sub-aspects. *Travel behavior*, in an express bus service context, deals with customers' route dedication, trip purpose, typical trip length, primary origins and destinations, transfers, and walking distance to/from bus stops. *Travel attitude* concerns customers' perceived travel time savings over local service, their willingness to pay premium fares, their preferences for express versus local service, and their level of satisfaction. The *socio-economic characteristics* of most interest to express service markets are household income and auto ownership. *Time savings* was added to *operational performance* due to its critical role in demonstrating the *raison d'être* of express bus service.

An agency's ability to use evaluation measures or indicators effectively depends to a large extent on its capacity for technical analysis. This capacity involves having the necessary know-how and technological resources to collect and process the data required by evaluation measures. Therefore, an agency must identify limitations in these areas when determining the most appropriate measures or indicators.

4.2.2.4 Express Service Standards or Guidelines

Just as it is important to *measure* progress toward achieving express bus service objectives, it also essential to set explicit expectations for desired market characteristics, service design and operational performance. Doing this helps the agency to stay on the right path in progressing toward the achievement of its objectives. These expectations can take the more rigid form of standards or the more flexible of guidelines. Both standards and guidelines play an important role in the evaluation process, so it is important to establish the right mix.

4.2.3 Organizing Evaluation Matrices

Using the proposed express service evaluation aspects shown in Figure 4-12, matrices can be developed according to the following tasks:

1. Identify key indicators and standards/guidelines based upon the evaluation sub-aspect of interest and express service objectives

2. Identify data needs based upon the indicators identified in step 1

3. Map the data needs identified in step 2 to the appropriate data collection techniques

Following are three matrices – each corresponding to the proposed express service evaluation aspect shown in Figure 4-12 – that have been developed following the steps listed above.

Figure 4-13: Proposed Evaluation Matrix – Market Characteristics

Evaluation aspect		Indicator	Standards/ guidelines	Data collection: Data needs	Data collection: Collection techniques
Market characteristics	***Travel behavior***	Route dedication: % weekly trips taken on same route	Min % for defining dedicated market	Travel patterns	- On-board, mail-back surveys - Electronic farebox transactions
		Trip purpose	Market research	Trip purpose	On-board surveys
		Typical pass. trip length in miles	Min % increase over local	- Unlinked passenger trips, total and by fare category - Pass.-miles -	- On-board surveys - Point check, end point load counts - Ride check on/off counts - Driver check - Electronic farebox
		Trip origin, destination	Min # pass./period	Travel patterns	- On-board surveys - O-D counts
		Transfer rate, location and connecting route, line	Market research	- Travel patterns - Transfer rates	- On-board, mail-back surveys - Electronic farebox transactions
		Walk distance to/from stop in feet, miles	Max. distance to/from stop	Travel patterns	On-board, mail-back surveys
	Travel attitude	Perceived time savings over local	Min. perceived savings over local	Travel attitude	- On-board, mail-back surveys - Focus groups
		Willingness to pay premium fare (fare elasticity of demand)	Max. level of sensitivity to premium fare	Fare elasticity	- On-board, mail-back surveys - Focus groups - Obs'd ridership changes in response to fare changes
		Preference for express, local	Min. preference for express	Travel attitude	- On-board, mail-back surveys - Focus groups
		Customer satisfaction	Min level of customer satisfaction	Customer satisfaction	- On-board, mail-back surveys - Focus groups
	Socio-economic	Household income	Market research	Socio-economic	On-board, mail-back surveys
		Auto ownership	Market research	Socio-economic	On-board, mail-back surveys

Figure 4-14: Proposed Evaluation Matrix – Service Design

Evaluation aspect		Indicator	Standards/ guidelines	Data collection	
				Data needs	Collection technique
Service design	***Interval/ headway***	Minutes between successive vehicles	Max. acceptable headway	Schedule adherence	- ride check: on-off counts (only if consec. trips checked) - point check: peak, end & mult. point loads - O-D count
Service design	***Pass. Flow***	- # pass./bus at busiest location - # pass/period at given headway - % standees/ vehicle at peak,	- Max. pass loading/ vehicle - % express pass. with seat at peak, off-peak	Peak, off-peak point loads	- ride check: on-off counts - point check: peak, end & mult. point loads - O-D count - APC: on-off counts - special
Service design	***Span of service***	- # pass/period at given headway	- time of first departure, last arrival, days of week - Min. # passengers/ period at given headway	- Schedule adherence - peak, off-peak point loads	- ride check: on-off counts - point check: peak, end & mult. point loads - APC: on-off counts - AVL - Trip time analyzer
Service design	***Stop spacing***	- average % spacing increase over local stops - average stop access/ distribution distance	- Min. & max. spacing difference from local stops - Max. average stop access/ distribution distance	- stop spacing distance	- route maps - GIS
Service design	***Route structure***	- average operating speed - # pass./ period - O-D pattern	- Min. % increase in average ops speed over local - Min. # pass/ period - capacity constraints and market characteristics of nearby routes, lines	- ons, offs by stop - transfer rates - peak, off-peak point loads - running time by trip, by segment - travel patterns	- ride check: on-off counts - point check: peak, end & mult. point loads - APC: on-off counts - trip time analyzer - AVL - O-D count

Figure 4-15: Proposed Evaluation Matrix – Operational Performance

Evaluation aspect		Indicator	Standards/ guidelines	Data collection	
				Data needs	Collection techniques
Operational performance	***Service quality***	- % trips arriving/ departing within more than X minutes of schedule	- Max. # trips arriving/ departing more than X minutes of schedule (depending on high/low route frequency)	- schedule adherence	- ride check: on-off counts - point check: peak, end & mult. point loads - O-D count - APC: on-off counts - AVL - Trip time analyzer
Operational performance	***Economic/ productivity***	- average # pass./ vehicle-hour - revenue/ pass. - subsidy/ pass. - average pass. trip length	- Min. average # pass / veh-hour - new route: Min. fraction of average express direct cost recovery - Max. subsidy (net cost)/ pass. - Min. % average pass. trip length over local	- peak, off-peak point load - unlinked pass trips - revenue - ons, offs by stop - pass. miles	- ride check: on-off counts - point check: peak, end & mult. point loads - APC: on-off counts - O-D count - driver check boarding count* - electronic farebox boarding count*
Operational performance	***Time savings***	- travel time (min)	- Min. % time savings over local, based on average express pass. trip length	- running time by trip, by average pass. trip length - ons, offs by stop - travel patterns	- ride check: on-off counts - point check: peak, end & mult. point loads - O-D count

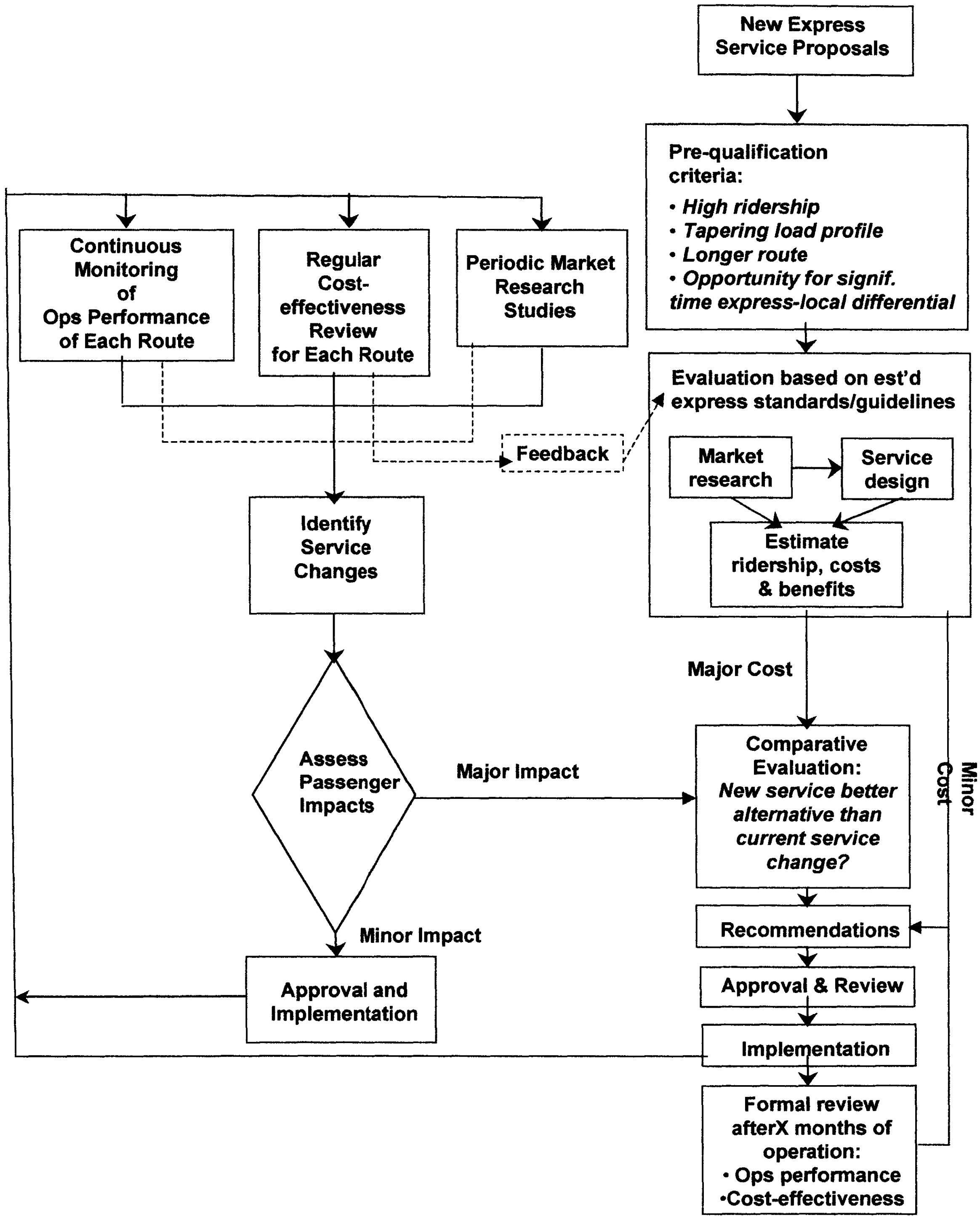
4.2.4 Evaluation: Existing Service Versus New Service

Once the agency has developed a detailed express service evaluation structure consisting of its goals, objectives, measures, and standards and/or guidelines, it is well positioned to follow through with service evaluation on a systematic, routine basis. The express evaluation matrices developed in the previous section can then serve as references for the agency's evaluation efforts in the cases of both existing services and new service proposals. Figure 4-16 presents an overview of this process.

For *existing* express services, the operational performance of the express route is monitored continuously using the indicators and data collection techniques organized in the evaluation matrix. A cost-effectiveness review is also conducted, though likely on a less frequent basis. A third, crucial task for evaluating existing express service involves periodic market studies geared to help the agency monitor trends in customer characteristics. Evaluation results in any of these three activities may require changes in the express service design. The passenger impacts of these changes are assessed, and if they are found to be minor, the proposed changes await approval and eventual implementation.

For *new* express service proposals to be considered, they must first meet pre-qualification criteria concerning the following favorable, corridor-level conditions for express service: ridership (high), load profiles (tapering), route length (relatively longer) and opportunity for minimum express-local time differential (significant). If these criteria are met, in-depth market research is conducted referencing the market characteristics evaluation matrix. Research findings are used to develop service design strategies (based on the service design matrix), and together they provide estimates for ridership, benefits and costs. If costs are determined to be minor, recommendations are made to approve and review the service proposal. At a designated period in time after its implementation, a formal review is conducted

Figure 4-16: Overview, Proposed Service Evaluation Process



of the route's operations performance and cost-effectiveness.

If the agency estimates either major passenger impacts from changes to existing service changes, or major costs from implementing an entirely new service, the existing and new service scenarios are compared. If changes to the existing service are considered to be the better alternative, they follow the same recommend-approve-implement procedure and are evaluated on a regular basis. If the new service proposal is favored, it is subject to the same formal review mentioned earlier.

4.2.5 Evaluation Action Levels

Evaluating express or limited-stop bus service involves not only identifying critical measures and data needs, but also defining success or failure in implementing and operating the service. In addition, it is necessary to identify the parts of the transit agency that are responsible for making key evaluation tasks actionable. The two primary levels at which these actions take place are through agency policy and agency operations. As seen in Figure 4-17, each evaluation aspect, be it express market targeting, service design or operational performance, carries with it imperatives at both of these action levels.

Figure 4-17: Evaluation Action Levels by Aspect

Eval. Aspect / Action Level	Market targeting	Service Design	Operational Performance
Policy			
Operations			

The policy action level is concerned with setting the overall tone and direction of the agency's efforts in creating and managing express bus services. The viewpoint on decisions made at this level is more strategic, focusing much effort on longer-term goals for express service development. A key policy task involves explicitly defining success and failure in express service design and management. Policy-makers within the transit agency also make decisions regarding the allocation of the resources necessary to undertake activities critical to each of the three evaluation aspects.

Evaluation actions taken at the operations level are more tactical, focusing on the shorter-term tasks of identifying critical data needs, data collection, and data analysis.

5 Chapter 5: CTA Recommendations and General Conclusions

The objectives of this chapter are the following:

- Provide a series of express service evaluation recommendations to the CTA based upon the approach developed in the previous chapter

- Draw a series of general conclusions about express service evaluation, based upon the findings of this research

5.1 CTA Recommendations

Many of the higher quality elements associated with competitive express bus service, such as increased stop spacing, higher operating speed, and increased customer comfort, are also key considerations for Bus Rapid Transit system design. The CTA is in a unique position to approach the development of routes like the X49 as an opportunity to incrementally upgrade to BRT status. As a result, many of the recommendations in the following pages identify policies and operational requirements for evaluating express bus services that are also useful in building toward a BRT future.

5.1.1 Overall Evaluation Structure and Key Aspects

Figures 5-1 and 5-2 below outline the overall evaluation structure and service aspects developed in the previous chapter that are critical to evaluating express bus services at the CTA.

Figure 5-1: Overview, Proposed Express Evaluation Structure

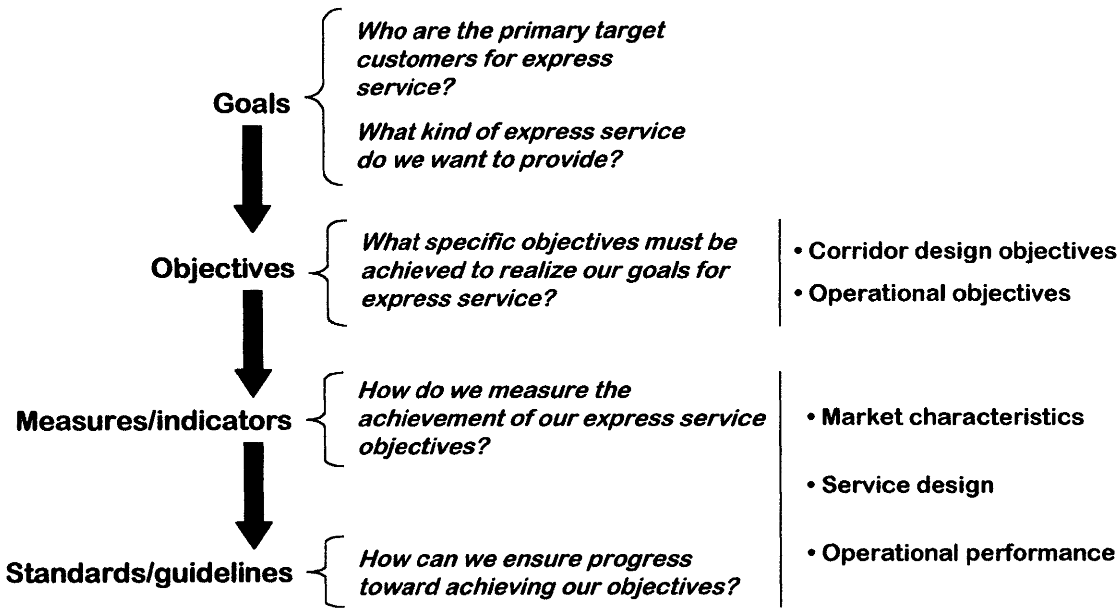


Figure 5-2: Proposed Express Service Evaluation Aspects

Market characteristics	• Travel behavior • Travel attitudes/preferences • Socio-economic characteristics
Service design	• Interval/headway • Passenger flow • Span of service • Stop spacing • Route structure
Operational performance	• Service quality/reliability • Economic performance/ productivity • Time savings

The following Figures, 5-3, 5-4 and 5-5, provide specific policy recommendations and accompanying operational requirements for each of the three principal evaluation aspects – market targeting, service design and operational performance.

When exploring the implementation of the recommendations included here, it is wise to use the list of key planning questions on pages 66-67.

5.1.2 Evaluating Express Markets

Figure 5-3: Market Targeting Recommendations

<table>
<tr><th colspan="2">Market Targeting</th></tr>
<tr><th>Policy</th><th>Key Operational Requirements</th></tr>
<tr><td>Board and executive staff: set goal for achieving 50% weekly express customer dedication by 2007
Over next 4 years, phase in successively stricter standards for minimum percentage of weekly dedicated customers</td><td>Data services staff: develop efficient sampling technique for monitoring express transit card data for usage frequency
Regularly identify usage frequency of individual express customers</td></tr>
<tr><td>Board and executive staff: explore guidelines for minimum percentages in perceived travel time savings over local 49</td><td>Market research staff: conduct semi-regular on-board and mail-back surveys of X49 and 49 customers
Examine X49 customer dedication threshold as a function of customer trip length</td></tr>
</table>

Market Targeting	
Policy	*Key Operational Requirements*

• Board and executive staff: if 2007 express customer dedication goal is met, initiate viability study of premium express bus fares
  ○ If demand sufficient, a premium fare could increase resources for providing higher-quality express service (e.g., lower headways, greater seating availability, power outlets for laptop/handheld devices, and other amenities)
  ○ This can solidify and expand the express customer base, as well as provide a test bed for BRT-oriented service elements (e.g., real-time information displays at stops)
	• Market research staff: conduct special study of price elasticity of express service demand under different service improvement scenarios

5.1.3 Evaluating Express Service Design

Figure 5-4: Service Design Recommendations

<table>
<tr><th colspan="2">Service Design</th></tr>
<tr><th>Policy</th><th>Key Operational Requirements</th></tr>
<tr><td>

Board and executive staff: set guidelines for maximum allowable express headway over local (in minutes), depending on length of route and average customer trip length

Higher express headways (e.g., >10 minutes) have greater potential to negatively affect customer perception of time savings, especially for shorter routes and average trip lengths (e.g., <5 miles).
If schedule adherence is poor, greater express headways may also adversely affect ridership on longer routes (e.g., the X49)

</td><td>

Market research staff: conduct study to determine express customer sensitivity to headway
Operations control and data services staff: pursue more active use of existing Automatic Vehicle Location capability to poll express vehicles for run time data
Garage-level supervisory staff: work with express operators to log in route number correctly
Operations, planning and route-level supervisory staff:

monitor express/local schedule adherence through regular on-off counts (only if consecutive trips checked); peak, end and multiple point load checks; or origin-destination counts

</td></tr>
</table>

Service Design	
Policy	*Key Operational Requirements*
• Board and executive staff: consider establishing guidelines for minimum and maximum express stop spacing differentials (in percentage terms) relative to parallel local route ○ Helps to ensure sufficient operating speed while keeping walk access distance to a minimum	• Service planning staff: maintain accurate inventory of current express and local stop spacing through Geographic Information Systems or physical maps

• Board and executive staff: set goal for achieving completely cashless fare payment using Smart cards on all express routes by 2007
  ○ Electronic fare box data will aid in evaluating degree of customer dedication
  ○ Use of Smart cards will also increase operating speeds by reducing vehicle boarding time
	• Garage and route-level managers: orient express operators on the importance of this goal
	• Phase-out presence of cash-operated fare boxes on express vehicles
	• Marketing personnel: conduct a sustained campaign to raise customer awareness

5.1.4 Evaluating Express Operational Performance

Figure 5-5: Operational Performance Recommendations

Operational Performance	
Policy	*Key Operational Requirements*
• Board and executive staff: set guidelines for expected elasticity of express service demand o e.g., minimum expected percentage increase in express ridership for every 1% increase in express vehicle-miles o Minimum should be used to justify increasing express service on a given corridor	• Data services staff: continue monitoring route level ridership changes following changes in express vehicle-miles • Service planning staff: o identify likely express demand elasticities based on ridership and vehicle-mile data o determine minimal elasticities required for express services to be viable
• Board and executive staff: set guidelines for minimum average express vehicle travel time savings over local (in percentage terms) o Based on average express passenger trip length	• Operations, planning and route-level supervisory staff: o monitor running time by trip and by segment through regular on-off counts at stops, as well as peak, end and multiple point load checks

Operational Performance	
Policy	*Key Operational Requirements*
• Board and executive staff: set standards for minimal average express customer trip length over local customers o e.g., minimum % increase over average local trip length o Indicates extent to which express routes are used for making longer trips	• Market research staff: survey express and parallel local customers on semi-regular basis for origin-destination information

5.1.5 Other Recommendations

5.1.5.1 Lane Exclusivity

The qualitative and quantitative observations made during the period of this research indicate that traffic congestion is not a problem on Western Avenue. Even construction work along the southern portion of the corridor – often occupying an entire lane in either direction – did not seem to slow traffic considerably. Given this apparent lack of need for automobile accessibility on all Western Avenue lanes, the CTA should actively explore the feasibility of securing an exclusive lane for the X49. A physically separated lane could make a potentially dramatic improvement on the X49's operating speed, thereby enhancing its time savings value to longer-distance riders.

5.1.5.2 Visual Cues

Evaluating services on the merits of their design and performance is a simpler task if customers can visually distinguish them from parallel local routes. Establish clear and consistent visual cues that help customers differentiate express buses and stops from parallel local routes (e.g., external appearance of buses, stop design, route information displays). Ensure that damaged or outdated visual cues are repaired on a regular basis.

5.2 General Conclusions

Express evaluation criteria should be indicative of its distinctiveness as a mode. Concrete indicators can easily be developed to measure key express service characteristics such as travel time savings over parallel local service, and average passenger trip length relative to local service.

Also, emphasis should be placed on evaluating express markets because the service's value can be gauged according to the dedication of its customers. This also has proven to be an express service aspect with practicable evaluation measures, such as the frequency of specific transit card usage (market dedication) using electronic fare box data. The viability of express services depends on customers that normally have more than one travel option. Therefore, it becomes necessary to pay closer attention to the design of those service attributes that are most likely to consistently attract these choice customers.

In addition, agencies should make explicit goals that reflect the specific value they seek to provide to express service customers. While this seems to be a critical step in the development of an evaluation structure for express bus service, its practical application is obviously more difficult to test than service design or operational performance indicators, for example. Decisions concerning higher-level agency goals, particularly those made by a governing board, are often subject to a wider variety of influential forces.

Lastly, many of the express evaluation measures developed in this research leverage the distinctive service attributes associated with express routes. However, the research revealed that there are a number of potentially distinctive express attributes, such as load factor policies that increase seating availability, that are not implemented for lack of resources. Fare premiums, while a political risk for some transit agencies, can improve the level of express service, and thus make more apparent the basis on which it is differentiated from other transit modes.

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